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THE ELECTRICAL REVIEW

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XX.—No. 500.

THEATRE LIGHTING.

A GREAT disaster not only creates a panic amongst those who are in immediate danger: it is an interesting occupation to the philosophic mind to watch its effect also upon thousands elsewhere who only await an event of sufficient magnitude to take leave of what few shreds of common sense they may possess. Many instances might be cited of much needed legislation, sought in vain for years, at length hurriedly effected in an incomplete or practically useless form, or perhaps in a form far too sweeping, as a consequence of some great catastrophe, or of a suddenly manufactured agitation, stirring the populace to a factitious enthusiasm. Such legislation is invariably unsatisfactory when in operation. We have an instance of the evil result of hastiness in law-making in the Electric Lighting Act of 1882, though it can scarcely be said that an Electric Lighting Act had been long required when Mr. Chamberlain's Bill became law. But there was in that case the typical rushing through of the Bill in a time of panic, with the usual consequence that its repeal or amendment is inevitable. The burning of the Opéra Comique in Paris nearly a month ago has called forcible attention to the dangerous conditions prevailing in theatre illumination, and there is some reason to fear that ill-considered measures may be adopted with the view of obviating the existing danger. Possibly not in this country, for when the direction is an obviously meritorious one, we are proverbially slow to move in it. But in Paris, in Lyons, and in other Continental towns and cities, as we have pointed out in recent notes and articles, decisive action has been quickly taken by the authorities with the laudable motive of preventing the recurrence of such a conflagration as caused bereavement in many Parisian homes last month. In these places electric lighting has been made compulsory. This is a decision with which, so far as it goes, we are not likely to grumble. But we feel the necessity of sounding a note of warning to theatre managers at home and abroad, whom we would inform that the mere adoption of the electric light will not necessarily ensure them the immunity which they desire. We recommend them all to instal the electric light at the earliest possible moment, for the reason that we believe it is the least dangerous form of illumination, the most certain, and the most useful: its advantages as compared with gas, oil, and other methods of lighting, in reducing the risk of fire in theatres and in private dwellings we have pointed out over and over again; its beauty is a thing which is obvious alike to the æsthetic and the uncultivated eye; and its adaptability to purposes for which the employment of other illuminants is impossible is being demonstrated daily. But we should be evading the truth, should be shirking an imperative duty, if we neglected to say that the sudden extinction of the electric light is not impossible, and that danger to life and damage to property are to be apprehended if the proper conditions are not observed. We scarcely need remind those who watch our columns of the breakdowns which have occurred at the Houses of Parliament, the British Museum, and elsewhere. The sudden change from brilliant light to utter darkness is, of course, a fruitful source of panic in large assemblies; therefore, whilst we recommend the electric light, we would insist upon the adoption of the most trustworthy systems—the most approved dynamos, both mechanically and electrically, the most durable lamps, the most thorough insulation of leads, and safety devices of the very best types. Above all we would urge the absolute necessity for the inclusion of secondary batteries as part of the plant, and these should be of sufficient capacity to keep up the lighting of the house in the event of a breakdown of machinery. In fact, the installation should be planned upon the most careful lines, with regard for the utmost certainty in the avoidance of accident by fire or otherwise, for the greatest possibilities in scenic effect, and for the convenience generally of actors and playgoers. An important factor in ensuring safety and certainty is the matter of conductors: these should be of a sectional area capable of bearing a current much in excess of that which it will normally be required to carry, should be insulated upon well-tried and thoroughly effective systems, and should be fixed in accordance with rules as rigid as they can be made within the bounds of reason, so that there may be perfect immunity from the danger of fire, and freedom from injury to the conductors themselves through careless handling, deliberate attempts to destroy them, alternations of moisture and dryness, or extremes of temperature. It being borne in mind that security is the great desideratum, the question of first cost should not be too closely debated, unless there is suspicion of attempted extortion. And here we would impress upon lessees or managers the advisability of being represented by electrical experts, who would check the work of the contractors and guard against loose estimates or excessive charges. The employment of competent men under skilled superintendence will alone secure the best results at the lowest comparative cost. In theatres, of course, the matter of decoration is an important one, and with a properly-installed system of electric lighting, lessees might rely upon effecting a considerable saving in the expense of renovation and re-decoration. This saving should be regarded as a set-off against the first cost of the installation; the working expenses should not greatly exceed those of gas, and quite possibly they might be kept at about the same figure. It will thus be seen that we strongly urge the adoption of electric lighting in theatres, but contend for discrimination in the selection of systems and methods. Too great care cannot be taken to be on the safe side in this regard, but once a right choice is made all uneasiness and all fear of fire or of panic should be at an end. We are very glad to learn from Mr. Berry that London managers are becoming more and more alive to the advantages of the electric light, and we anticipate a period when a theatre or music hall without it will be the exception rather than the rule.

INSULATION OF ELECTRIC LIGHT CONDUCTORS.

(Continued from page 568.)

RESINS.

RESINS have been used alone, but are generally employed in conjunction with cotton tape or jute; they are frequently mixed with tar and other ingredients. In a few cases the conductors have been laid down in wooden troughs, but the outer protection has usually been a lead or iron pipe.

Resins alone are very brittle and readily crack; the insulation is consequently lost, owing to the hygroscopic nature of the material, and the aptitude of cotton and jute to absorb moisture.

The melting point of most resins is fairly high, but when mixed with tar or similar ingredients, so as to reduce the brittleness through the solvent action of the lighter oils, this heat-resisting quality becomes dangerously reduced. It is extremely difficult to prepare these compositions so as to avoid, on the one hand, their being too hard and brittle, when they crack, and, on the other hand, too soft, when the conductor, from ordinary gravitation, sinks through them. Where melted resins or compounds have been run round the conductor into pipes, it is evident that it must be almost impossible to obtain proper centering during manufacture, and this defect alone is of a serious nature, but there are now methods of manufacture which reduce this risk to a minimum.

Short sections, tubes, or beads of either glass, porcelain, or earthenware have been employed over the resin as an additional protection. It is hardly necessary to state that this contrivance has proved utterly ineffectual.

ASPHALTUM, BITUMEN, AND BITUMINOUS COMPOUNDS.

We have in these, one of the earliest methods employed for insulating underground wires, bitumen having been used for ordinary underground telegraph work more than 30 years ago; it was, however, speedily abandoned.

It is employed either alone or mixed with other ingredients, such as coal tar, linseed oil, sulphur, &c., and frequently in combination with cotton tape or jute fibres, impregnated with the bitumen. It is run in a melting state into the lead or iron pipes, or wood or cement troughs carrying the conductor, or is made into a so-called plastic sheet by the admixture of certain compounds, and laid in coatings on the wire.

Bitumen by itself is too brittle, in ordinary temperatures, to be relied on, and is easily affected by heat. When mixed with other compositions the specific insulation resistance is very low, and the mixtures are disposed to absorb moisture. It is not easy to see how it can be made into a plastic sheet (as has been claimed), for it seems impossible to render bitumen properly flexible, even when mixed with tar or other hydrocarbons. The present Callender process, in which, we believe, it is stated that vulcanised bitumen is an especial feature, is, of course, an improvement upon the method employed some two or three years ago. Our knowledge regarding the latest form is sufficient to permit of a favourable judgment being made as to its pretensions, some $\frac{9}{10}$ths of the total mileage of underground electric light cables being supplied by Messrs. Callender, but we must confess that we do not quite understand how bitumen can be vulcanised, although we are aware that it can be oxidised.

When India-rubber and gutta-percha are vulcanised they become insensible to ordinary changes of temperature, and they acquire greater tenacity, but oxidation of bituminous materials has only the physical result of rendering them hard.

The so-called vulcanising in the Callender process may be an oxidation and consequent hardening of some of the oils contained in the mixture.

There have lately occurred a good many instances in the United States of the unsuccessful employment of bitumen or asphalte for insulating purposes, in some cases failure resulting in two or three months after the wires had been laid down. We understand, however, that with a proper admixture of silica, and thoroughly kneaded and hammered into a consistent mass, bitumen has been very successfully employed in the construction of conduits for carrying insulated conductors.

TAR AND PITCH.

These substances have been used alone or mixed with other ingredients such as a beeswax, white lead, tallow, paraffin, silicious sand, &c. In some installations bare conductors have been laid in wooden troughs or cement conduits, which have then been filled up with the composition. In other cases the tar or pitch has been run round the conductor in pipes of lead or iron.

The specific insulation resistance of tar and pitch is very low. Various insulating oxides have been tried in admixture for the purpose of increasing the insulation, and china clay is sometimes added in order to stiffen the composition and give it sufficient consistency.

This process, however, does not improve the insulation, and the clay only serves to render the compound much too brittle, and one of the disadvantages connected with the employment of these materials and their kindred compounds, is the difficulty experienced in attempts to make them sufficiently flexible.

When used in troughs or conduits, tar and pitch, more especially when mixed with other compositions are, from their disposition to attract moisture, extremely unreliable.

There is also much difficulty in preparing these materials so as to render them, without their becoming too brittle, sufficiently hard to prevent the conductor sinking through them from mere gravity.

When used as an additional protection, as is often the case, to wires properly insulated with India-rubber or gutta-percha, there exists the objection that in the distillation from coal tar, there is always the danger of certain lighter oils not passing over, and whose presence, owing to their solvent action, is most injurious to rubber and percha.

Tar and pitch have been used to a considerable extent in the United States, but so far as we can learn, have proved signal failures.

PARAFFIN.

Though frequently made use of, the employment of paraffin is open to many objections, one of the most important being that while cooling it shrinks and consequently cracks.

It has been used run in a melting state into a lead or iron pipe, through which the conductor wound with cotton tape or jute fibres, is taken. Here, again, the mechanical difficulty of properly centreing the wires is a sufficient reason for condemning this method.

With regard to the shrinking, many attempts have been made to prevent this, but even were they successful, the paraffin could never be made tough enough to hinder the conductor, from mere gravity, sinking through. It has also been found that tapes, soaked in paraffin, though answering well at first, decay in a comparatively short time, probably through the action of free acids usually found in commercial paraffin.

In the Berthoud-Borel process (roughly describing it) the conductor is covered with several layers of cotton, spirally and reversely laid on; it is then placed in a bath of paraffin and colophane, and finally protected by a covering of lead. The resinous qualities of colophane, and the disadvantages connected with the use of paraffin, in addition to the difference in contraction of these substances on cooling, which would offer the imperfection of rendering them to a certain extent porous, are, we think, objections, although we know of many successful applications.

We see it stated that in America an installation on a considerable scale, is to be supplied with conductors insulated by Waring's system. This, we believe, consists in covering the wire with cotton or jute, impregnated with petroleum residuum, and then protected by a lead or iron pipe. In time, as petroleum has a considerable affinity for moisture, which sooner or later is sure to penetrate, the cotton or jute covering will decay, being unprotected by any really preservative compound.

VULCANISED OILS.

The well known properties of so-called vulcanised oils are sufficient reasons, we think, for condemning them without much hesitation. Most of the oils used contain acids in sufficient quantities to endanger the conductors. They are not good insulators, and withstand but a moderate degree of heat. If used alone, they have not consistency enough to prevent the conductor sinking, and when mixed with oxides of metals, china clay, or other pigments, for the purpose of stiffening, the composition becomes too brittle. No matter what compounds are employed, it has been found practically impossible to obtain the proper mean between a too fluid and a too hard condition, for the process of oxidation cannot be followed with sufficient minuteness. As in the case of bitumen, we must protest against the term of "vulcanising" being applied to this process, which is simply oxidation.

ASBESTOS.

Asbestos fibres are sometimes used alone, round the conductors, which is then protected by a lead or iron pipe. Though asbestos resists the action of acids and heat, the insulation is not good. Its fibrous nature and power of capillary attraction, must render it subject, dealing with it from an electrical standpoint, to the effects of moisture.

A mixture of ozokerite and asbestos has been tried, but the difficulty of working these materials into a homogeneous mass is a sufficient bar to the employment of this composition.

Another form, consisting of a covering of asbestos braid laid either under or over a coating of India-rubber might certainly for a time possess the good insulation claimed for it, but we fancy that the non-conducting properties of asbestos would lead, in the first case, to the overheating of, and consequent injury to the conductor; and, in the second case, to damage to the India-rubber—on which the insulation of such a conductor almost entirely depends.

OZOKERITE.

Several methods of employing this substance have been tried, one of the most familiar being Henley's system of curing India-rubber core in melted ozokerite under pressure so as to get rid of all moisture, the core being then heated in hot ozokerite, which is forced through the India-rubber, so as to stop up the pores.

A mixture of ozokerite and India-rubber (called "nigrite") has also been tried, but was found to have too little consistency to be of much mechanical value.

There is much difficulty in the mixing of ozokerite with other materials so as to obtain a thoroughly homogeneous mass. The melting point is fairly high, and it resists the action of most acids, but it is open to many of the objections which apply to the use of paraffin.

We believe it is often used in admixture with India-rubber, but it should be remembered that the mixture of ozokerite, or of any resinous matter with rubber, invariably injures the latter. An application of this nature is all the more to be avoided because of the apparently good results obtained at first and for a short time, but which are very misleading with regard to the mechanical endurance of the material.

KERITE

is used alone round the conductor, or in conjunction with cotton tape or jute, in both cases having an outer protection in the shape of a lead or iron pipe. It has been largely employed in the States, but in general with unsatisfactory results.

Kerite is an inferior mixture of India-rubber, oxidised oils, and other compounds. Being vulcanised, as it is called—in reality, oxidised—it stands great heat, but, in time, becomes very brittle. In common with many compositions, the insulation is at first high, but it rapidly loses this attribute. Mechanically, it has but a short life—the India-rubber suffering from the deleterious effects produced by the excess of other mixtures.

COTTON, SILK, FLAX, AND JUTE

are used as insulators, either simply or impregnated with some insulating or preservative composition, and protected by an outer coating of some varnish.

These materials from the ease with which they absorb moisture cannot be depended on for insulating purposes; it is nevertheless a fact that they have been tried as main conductors, needless to say unsuccessfully, for the varnishes used to protect the cotton are on the one hand too brittle and insufficiently adhesive, or when prepared so as to avoid this defect are too soft, poor in insulation, and unable to withstand a high temperature. No doubt there are occasions in which conductors covered in this manner may be successfully employed, but their use is to be deprecated when properly insulated leads can be obtained.

In the case of winding dynamos where space is a matter of consideration, and where the wires are not exposed to being moved about, cotton covered wires, coated with shellac, can be safely used; but if high tension machines are employed, the wires should be covered with silk instead of cotton.

The tendency of every fibrous material is to express any known composition injected into it. This is all the more remarkable in the presence of water, to which the fibre seems to have a greater affinity than to compositions, so much so that the latter are in a comparatively short time almost entirely replaced by water, the time of course depending on the nature and consistency of the injected composition.

Cotton covered wires are used to a considerable extent in the United States, a very common form being where the cotton is double braided and impregnated with some non-inflammable solution, such as silicate of soda or potass, sugar of lead, &c. These wires are usually employed on high tension circuits, suspended on posts, and the covering is intended to be a protection in case of one wire falling across another, as well as to comply with the rules forbidding the employment of bare wires.

To a certain extent only is this covering non-inflammable, and it cannot pretend in the slightest degree to be an insulator. We believe we are correct in stating that this form is known as "Underwriter's Wire," but we do not know why this particular system should, among the many equally defective ones, alone bear such an unenviably distinctive title.

We notice that in many systems some reliance seems to be placed on a multiplicity of tapes. This is to be avoided partly on account of the objections already mentioned, to the employment of fibrous material, partly because the tapes are apt to split when the leads are submitted to bending or torsion.

(*To be continued.*)

THE ARON ELECTRIC METER.

MUCH attention has been devoted for several years to the perfecting of an instrument to take the place, in electric lighting from central stations, of the gas meter in gas lighting.

Several forms of registers have from time to time been introduced, but have not come into general use, for they have not complied with the requirements such an instrument must fulfil.

Amongst the desired requirements are:—

1. Great accuracy.

2. The indicating device must give the consumption in *direct* electrical units, that the consumer may understand it and check the supply.

3. The whole of the current flowing in the circuits must pass through the instrument, and not merely a shunted current.

4. It must register the minimum as well as the maximum quantities, *i.e.*, the consumption of one lamp as accurately as for 100.

5. It must be automatic and require no skilled attention.

6. It must be free from the influences of external currents.

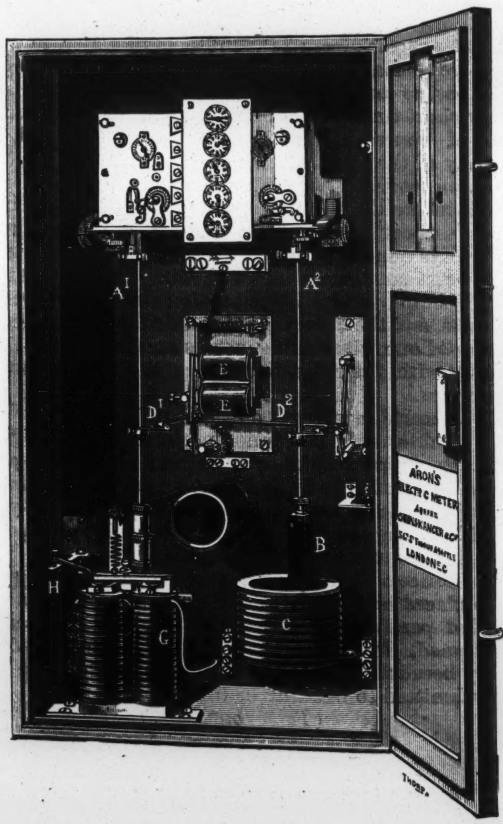
We have had occasion to refer to the meter patented by Dr. H. Aron, of Berlin, on previous occasions in these pages; a number of these meters have been in constant use in central lighting stations in the German Empire, where, we are informed, they work in such a highly satisfactory manner that over 1,000 have been now supplied.

Dr. Aron has recently greatly improved upon those now in use, and is giving the English market preference of the first supply through Messrs. G. Binswanger and Co., who have, we are informed, the sole right of sale in this country.

The general principle of differential clockwork gear is the same in the new form as in the earliest ones, and is a principle which, we believe, the eminent professors, Messrs. Ayrton and Perry, have before mentioned.

It is well known that the duration of the oscillation of a pendulum is varied by an alteration of either its length or weight.

The application of this principle is used in the construction of the Aron meter, illustrated below.



Two pendulums, A^1, A^2, are worked by two distinct clockwork gears. One, A^1, is a standard and oscillates at a regular speed; the second, A^2, has a permanent magnet, B, instead of a weight, and is variable in its speed.

The variation is obtained by passing the whole current through a solenoid of thick wire, C, placed underneath (but not touching) the magnet, B. The magnetic influence has an accelerating effect on the pendulum, A^2, in direct proportion to the current passed through.

This produces a corresponding increase in the speed of the clockwork gear regulated by this pendulum.

A direct reading of variation in the speeds of the standard and variable clockwork is given by an ingenious differential gearing with speed-counting dials, calibrated to read in direct units, on the same principle as a gas meter.

The slightest alteration in the current consumed is recorded by the whole current being passed through the solenoid, C.

Both pendulums are controlled by catches, D^1, D^2, which are again controlled by the armature of an electro-magnet, E, placed in a shunt circuit.

These catches form a self-starting gear and work as follows:—

An electro-magnet, G, is wound with wire the same size as that on the solenoid, C, and placed in series with that solenoid. The armature of this electro-magnet has attached to it a spring, H, which, when the armature is closed closes the shunt circuit, causing the controlling magnet, E, to release the pendulums.

This arrangement also ensures the recorder remaining stationary when no current is being consumed even in the event of the main switch between the service mains and the house being left shut.

Objections may be raised to the use of clockwork, but if it is well made, as in the present instance, it can be as thoroughly relied upon as a good clock itself.

In this improved meter the clockwork winding lasts 18 days, if in constant use, but if in part use, as is generally the case, it will serve for two months.

The instrument we saw at Messrs. Binswanger's has every appearance of a well finished and lasting piece of workmanship, and is enclosed in a dustproof case so that it can be placed in any position that suggests itself as convenient. It is undoubtedly a further step in the direction of perfecting central station lighting.

THE NEW ELECTRIC LIGHT SYNDICATE.

THE advent of this new primary battery company is heralded by the flourish of trumpets usual on such occasions, and by the wholesale condemnation of what has been previously done in the subject; thus the public are informed that "although numerous primary batteries have lately been introduced to the public, *none* (the italics are our own) have been of any real utility." If this statement is actually correct, the new primary battery of the New Electric Light Syndicate would, we think, fairly come under the same condemnation.

The new battery, the invention of Mr. C. Maltby Newton, may be very good of its kind, but we can see nothing in it to justify the somewhat extravagant pretensions which are claimed for it. The exceedingly low initial electromotive force of the combination is, in our opinion, sufficient to condemn it as a practical source of power; this force at the best does not exceed ·75 volts, and in actual practice it appears to be less still.

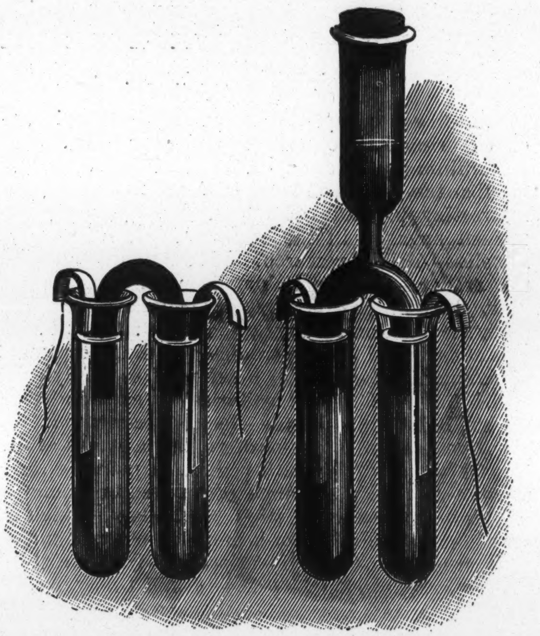
The tests taken for the syndicate by Dr. Walmsley are in themselves fair enough, they are simply statements of facts, and they show that the current obtainable from a particular size of cell does not fall more than 10 per cent. in about 130 hours. We have, however, nothing given to indicate why the new battery is likely to prove more successful than those already on the market. The idea that profits will result from the bye-products is simply an absurd one; it is an idea constantly brought forward, and is well known by practical men to be utterly fallacious.

It is stated that "the prime cost of a battery ready to feed, say, 48 lamps of 10 candle-power each, is about £145. For the sum of £56 5s. per annum, which includes 'wear and tear' of plant, these could be maintained for five hours per day, and by adding 10 per cent. for the working expenses, this comes out equal to gas at 2s. 10d. per 1,000." No calculations are, however, given to substantiate this statement, which is open to grave doubts.

STANDARD DANIELL'S BATTERY.

THE sulphate of copper battery is probably more used as a standard of electromotive force than any other, writes Dr. O'Conor Sloane in the *Scientific American*. Various forms have been suggested and adopted. Among the features to be secured are permanency and freedom from tendency to local action. In these and other respects, the battery as usually constructed is defective, as it is emphatically a two-fluid cell. It is essential that the plates should each be immersed in a particular fluid, and that the fluids should not mix.

To secure this end various means have been adopted. The porous jar form is very commonly used. But as a scientific apparatus this is defective. The pores of the jar become filled with the battery salts, and to start new this may require quite a lengthy process of cleaning. Then it sometimes happens that metallic copper precipitates upon the surface of the porous jar, rendering it quite *hors de combat*. Thus the mere fact of the use of such a jar introduces an element of complication.



In the cut is illustrated a very simple and cheap form of cell that avoids most of the troubles usually affecting Daniell's battery. Two forms are shown, one of the simplest possible description, the other a modification designed to secure lower resistance, and admitting of the convenient use of a septum of gold beater's skin or other membrane.

The simpler form is constructed with two test tubes, a small bent glass tube, and the plates and solutions. Two test tubes are placed in a stand. A piece of glass tubing is bent in a smooth curve, so that when in place it will extend from one to the other, as shown. This should be about 3 mm. ($\frac{1}{8}$th inch) in internal diameter. A piece of copper for negative plate, and of zinc for positive plate are provided. To each a wire is connected by soldering. The desired solutions must now be prepared. The strength is of course to be fixed by the experimenter, according to the results he wishes to obtain from the battery.

The use of saturated solutions is very usual. Assuming such to be employed, one of the test tubes is nearly filled with a saturated solution of copper sulphate. The other one contains a saturated solution of zinc sulphate. The latter is the heavier fluid. The bent tube is now filled with the same solution of zinc sulphate. If it be held while thus filled with its two open ends down and open, it will not empty itself. The least jar or shake will cause it to do so; but by careful handling it can thus be carried from one vessel to another. Having then filled it with the solution, which is easily done by siphoning, it is carefully lifted up as described, and lowered into the solutions in the test tube. To be sure that no air bubbles rise into the bend, it is well to have the zinc sulphate tube filled to the higher level. Then, on introducing the bent tube, a little of the zinc solution will first siphon over and sink to the bottom of the copper solution. A slight mixing of the solutions is not prejudicial, provided no copper solution comes in contact with the zinc plate. The bent tube having thus been introduced, the copper plate is placed in the test tube containing copper sulphate solution, the zinc plate in the other tube, and the battery is ready for use.

It is of extremely high resistance, and no porous septum is used to secure more perfectly from mixture. A slight mixing of the solutions in setting up, moreover, cannot well be avoided. The other form overcomes these troubles, and also gives a cell of lower resistance. The bent tube is made of larger diameter. It may be nearly as large as the test tubes. To the apex of its bend a capillary tube, opening into a large tube, is connected. If desired, a septum may be tied over one of its lower ends. The tubes are filled with their solutions, the bent tube is placed in position, and by suction the liquid is drawn up until it rises through the capillary tube, well into the larger one. The suction is stopped and the end left free. The liquid naturally sinks, but, owing to the small size of the capillary tube, with such slowness that a cork can be inserted, without trouble, into the suction tube. The plates are put into their places, and all is ready for use.

If a piece of membrance is used, it should be tied over the end of the tube which is immersed in the solution of higher specific gravity, containing the sulphate of zinc. It is well also, in this case, to pour into that limb through the suction tube a quantity of the zinc sulphate solution. The level of liquid in the test tubes and the length of the straight portions of the bent tubes must be so adjusted that enough liquid will be left in the test tubes after the filling of the connecting tube. To make this easier to effect, it is well to use test tubes of large diameter, or even small beaker glasses.

PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

Continued from page 424.

Expansion of oxides and buckling.—We have already stated, in the last paragraph, that the paste of read lead expands during oxidation and also while sulphating. We have mentioned that this increase of volume was the main cause of the detachment of the oxide from its flat lead support. It is this expansion of the active material that has been the cause of most of the trouble experienced with lead storage batteries. Whether the paste is packed into holes, grooves, corrugations, slots or reticulations, the process of enlargement in positive plates goes on, and buckling, falling out of oxide, and other deteriorations follow. The cause is known, but it is somewhat difficult to find a remedy. We cannot prevent expansion or do away with the natural properties of oxides, but we must aim at the production of plates in which an increase of volume can occur without distorting the shape of the electrodes. The materials, active and conducting, must be distributed in such a manner that any growth shall take place equally all over the surface. Until this can be accomplished, *buckling* and bending is sure to take place with the disastrous results well known to makers and users of secondary batteries. Oxidation of the positive plates must occur when the cells are being charged, and sulphating takes place whilst they are discharged. In the case of perforated plates the paste expands and with it the lead support during oxidation. The lead support has practically no elasticity, therefore the paste would become loose during the discharge were it not for the compensating effects brought about by the sulphate which is formed simultaneously. If the active material did return to its original volume, then the contact between it and the metallic support would be almost destroyed. Positive plates grow slowly but continually; their volume increases gradually; and since the paste does not return to its original shape, old and well used plates must be more porous than new ones. This greater porosity may account for the increased capacity of positive plates which have been in use for a long time.

The volume of oxides relatively to their metals has been calculated by chemists. When 207 grammes or 18·44 cubic centimetres of lead unite with 16 grammes of oxygen to form $Pb\,O$, the increment of volume is found to be 2·6 cubic centimetres. In the oxidation of 112 grammes of iron to $Fe_2\,O_3$, the increment of volume is 8·1 or 3 × 2·7 c. c.; thus 16 grammes of oxygen in chemical union with heavy metals occupy 2·6 to 2·7 cubic centimetres.

In practice, with battery plates, only a portion of the active material becomes oxidised, therefore the above proportions, which refer to atomic volumes, cannot be applied unless we know how many molecules there are exposed to the action of oxygen. If every atom of the lead could be utilised, then the increase of volume from Pb to $Pb\,O$ in the first stage of oxidation would alone amount to $\frac{2{\cdot}6}{18{\cdot}44} = 14$ per cent; this increment, if $Pb = 1$, to $Pb\,O$, would be 1·14; to $Pb\,O_2 = 1{\cdot}28$, and so on. We have found that a positive plate which had a surface of 9 × 10 = 90 square inches when new, grew to 94·76 square inches after one year's daily use; we only measured the expansion in the direction of length and width; older plates of the same description showed an increase of from 90 square inches when new, to 97 square inches when almost worn out. A positive plate is considered to be worn out when its lead support, or grid, is broken or cracked to a considerable extent. Metallic lead becomes very brittle in course of time when exposed to the electrolytic action of oxygen, and a period arrives when the grid refuses to extend itself with the increasing volume of the paste. The bars of the grid crack, and these cracks gradually open out, and then the whole plate becomes unserviceable.

We endeavoured to strengthen the plates by providing stout ribs, diagonally, parallel to the sides, and in various other ways, but we found that this only aggravated the evil. The portions of the grid which were surrounded by strong ribs, expanded and buckled in any direction that offered the least mechanical resistance, whilst the ribs themselves did not elongate in the same ratio.

This method of stiffening grids had to be abandoned, and, finally, we came to the conclusion that any attempt to strengthen positive plates by mechanical means was fruitless. We must allow the paste free scope for expansion in every direction, and this can be done by making the grid or supporting frame of equal strength throughout, and the softer the conducting material the better for the plates. It was suggested, some five years ago, to strengthen the lead grid by providing an alloy of antimony and lead, whereby a much stiffer plate could be obtained. This plan was tried by the Electrical Power Storage Company in the year 1882, but the results were not entirely satisfactory, and the reason for this partial failure will be explained hereafter.

When the cells are partially or wholly discharged, and then left to stand idle, sulphate is being formed, and buckling sets in at a comparatively rapid rate, even with well-constructed plates. To counteract this tendency, secondary batteries should always be kept well charged. If one face of a plate is slightly more active than the other, it is natural that the most active side will expand first, and thus become convex, and when buckling has once begun it continues very easily, and eventually the paste, for want of elasticity, will break and tumble out.

All sorts of devices have been tried to prevent buckling, and consequent contact between neighbouring plates. Wooden frames were tried, grids of ebonite, India rubber, and other insulating materials have been used; bands were stretched round the plates, and, finally, rubber plugs, spaced at short distances all over the plates, have been adopted to keep them flat. All these and other kinds of separators, however, do not remove the *tendency* to buckling or unequal expansion; such supports are merely a rude remedy, but they do not do away with the cause. There is only one rational cure, and that is to make the grids of equal strength all over, apply the paste with care, so that it should not be more dense in one part than another, and then leave the plates as free and unconstrained as possible by giving them room for expansion. These are manufacturing details. As regards maintenance, we have already stated that excessive sulphating can be prevented by never allowing discharged cells to stand idle in acid for any length of time.

(*To be continued.*)

ELECTROLYSIS OF ALUMINIUM SALTS.

By ALEXANDER WATT.

HAVING been occupied during many months in a series of experiments conducted with a view to deposit aluminium by electrolysis, if possible, it occurred to me that the details of some of these trials might prove interesting to those who have worked, or may be at present engaged in the same difficult—if not almost hopeless—field of research. If I am unable to enlighten the reader so far as to put him in possession of a method by which this refractory metal may be deposited from the solution of any given salt, at least I shall be able to spare him some trouble and disappointment by directing his attention to a series of electrolytes from which the metal cannot, so far as my experiments have shown, be obtained by the electrolytic method. These negative results may, therefore, be accepted as directing the way *not to go*, rather than as pointing the road to success. In the course of my experiments with aluminium, I not only tried solutions of which I had seen no published record, but also most, if not all of those from which others had professed to have obtained the metal by electro-deposition; and I may say, so far as my own experiments are concerned, that the published processes that I tried failed to yield a deposit of aluminium in any one case. That a white metallic deposit was obtained upon the cathode in nearly every instance, soon after, or at the moment of immersion of the negative plate—say, a clean strip of brass, gilding metal, or copper—I admit, but that the trifling film so obtained (and which invariably ceased to show after a very short time) was aluminium, I fear I must not only doubt, but deny. I will not go so far as to assert that the electro-deposition of aluminium from its solutions is an absolute impossibility, for in several of my results the presence of the metal upon the cathode—albeit in very minute quantity—was proved beyond doubt; but why the deposit should suddenly cease, and the same bath fail to yield a further deposit upon a newly prepared plate, I was unable to determine, although every effort was made to repeat the experiment under precisely the same conditions. It is moreover remarkable that the only instances in which the presence of aluminium upon the cathode were indisputable, were those in which the deposit appeared, not in the form of a film, but of a granular character, the particles of metal being interspersed with bubbles of hydrogen, which rested firmly upon the plate, and could not readily be displaced by merely moving it briskly about in the bath, as is usually the case, but required to be wiped or brushed off the surface every few moments; and even when this was repeatedly done, the plate exhibited a spotted appearance, the naked metal of the cathode being visible wherever the globules of gas had persistently lodged.

In describing the experiments referred to, it will be convenient to divide them into three classes: I.—Experiments with Acid Solutions. II.—Experiments with Alkaline Solutions, and III.—Experiments with Fused Salts of Aluminium. In the course of the trials, Bunsen, Daniell, and Lalande batteries were used, but most of the results were obtained with Lalande's oxide of copper battery, arranged in series—from two to twelve small cells being employed in some of the smaller experiments, and from two to six twenty-gallon cells in the larger trials. The anodes employed were of platinum, or carbon, according to the character of the electrolyte; platinum foil was also frequently used as a cathode, so that the deposited metal could be readily dissolved off from time to time, and the solution tested for aluminium. In some cases, however, strips of gilding metal and zinc, to each of which a copper wire was soldered, were used as cathodes.

I. *Experiments with Acid Solutions.*—1. A solution of sulphate of alumina was prepared by digesting calcined China clay in sulphuric acid for many hours, with moderate heat. The sulphate thus formed was then dissolved out with cold water, the solution filtered, and used as an electrolyte. A platinum anode and strip of gilding metal for a cathode were employed, with the current from six small Lalande cells in series. In this case there was a trifling and partial deposit, somewhat in the form of a horse-shoe, which proved to be iron; beyond this the solution refused to give up its metal, whether cold or hot. Increase of current gave no better result. A solution of commercial sulphate of alumina ("concentrated alum") of various degrees of strength was also tried, but with the exception of slight metallic streaks, which were not aluminium, however, no deposit was obtained.

2. Potash, soda, and ammonia alums in solution yielded trifling metallic deposits, but not aluminium.

3. Basic sulphate of alumina, prepared by various well-known formulæ, was also tried, but though slight films of white metal were deposited upon the cathode from these solutions, the deposits turned out to be due to metallic impurities of the aluminous salts from which the several solutions had been prepared, and not to aluminium itself. To get rid of these impurities, if possible, the following course was adopted: Hydrate of alumina was precipitated by means of a solution of carbonate of soda, from a solution of ammonia alum and the precipitate very carefully washed, and re-dissolved in pure dilute hydrochloric acid. The hydrate was again thrown down from this solution by ammonia, and after careful washing it was dissolved in dilute sulphuric acid. Ammonia was then added, gradually, and the precipitate formed allowed to re-dissolve after each addition. The solution thus obtained still yielded a slight metallic deposit, but it was not aluminium: the film upon the cathode when treated with hydrochloric acid only partially dissolved, and its solution, when tested with ferrocyanide of potassium, gave a purplish precipitate, indicating, probably, manganese. Small additions of sulphuric acid were made to the bath, when a slight film again appeared upon the cathode, but on immersing a second plate no further deposit could be obtained; the film was proved not to be aluminium, so the bath was abandoned.

4. Hydrated sesquichloride of aluminium, prepared by dissolving hydrate of alumina in hydrochloric acid, failed to yield a deposit of aluminium, in either hot or cold solutions.

5. The same solution, with chloride of ammonium added, also failed to give up its aluminium. These solutions were tried at various degrees of concentration, both hot and cold, and with gradually-increased strength of current, but without success.

6. The double chloride of aluminium and potassium, in solutions of various degrees of density, were tried, both cold and hot, but no deposit of aluminium was obtained.

7. The double chlorides of aluminium and sodium, tried under similar conditions, were equally unsuccessful.

8. Nitrate of alumina, prepared by dissolving freshly precipitated hydrate in nitric acid, failed to yield a deposit of aluminium.

9. Sulphate of alumina, dissolved in a small proportion of water and neutralised with an excess of freshly-prepared hydrate of alumina, was also tried. After a long immersion of the plate (a strip of brass) a granular deposit occurred in various parts of the surface, these particles being intermixed with bubbles of hydrogen, which remained persistently on the plate, and could only be removed by brushing them off; merely moving the plate briskly about in the solution did not displace the gas entirely, many bubbles still adhering, even with this rough treatment. The granular deposit referred to, when dissolved in hydrochloric and tested for aluminium, gave evidence of the metal (not wholly pure, however), but beyond such trifling results as these the solution failed to give up aluminium. In the hope that this slight evidence of metallic aluminium having been deposited might lead to better results, a great many experiments were made with the same electrolyte, both weak and concentrated, with a progressive increase of current; but all these trials ended in failure. A bath of about sixteen gallons of the neutral sulphate was thereafter tried, and the solution kept in constant circulation, but no deposit of aluminium took place after a long immersion of the electrodes.

10. Sulphate of alumina and sulphate of magnesia, each dissolved in water and the solutions mixed, was also tried, but without success.

11. Small quantities of the vegetable acids, acetic, oxalic, citric, &c., were each, in turn, added to baths composed of the neutral sulphate of alumina, but no favourable result was obtained in either case.

12. Acetate of alumina, prepared by dissolving the moist hydrate in strong acetic acid, and afterwards diluting the solution, was tried, when a bright white metallic deposit was obtained; this was not aluminium, however, but due to metallic impurities (chiefly zinc) derived from the hydrate of alumina. It may here be mentioned that in some of these experiments the hydrate used was supplied by a highly respectable manufacturing firm; but in many cases it was prepared by the author himself. The product obtained from the former source contained more than a mere trace of zinc, but how it found its way into the hydrate of alumina it has been found impossible to discover. In all the experiments, however, the baths were worked until they ceased to yield a deposit of any kind (whether cold or warm), either with weak or strong currents, and the deposit on each plate was tested for aluminium while its successor was in the bath.

13. Citrate of alumina, in a moderately strong solution, only yielded a slight deposit of white metal, but not aluminium. Stronger and weaker solutions were tried, but without any result.

14. Tartrate of alumina, in solutions of various density, was also tried without effect.

15. Mixtures of the solutions prepared from vegetable acids and the sulphate of alumina solutions, failed to yield deposits of aluminium.

16. Thinking that possibly the presence of some metal less positive than itself might favour the deposition of aluminium, a solution of bichromate of potash was added to a solution of the sulphate of alumina, but with no beneficial result. Perchloride of antimony was also added to the alumina sulphate solution without effecting the object in view, for antimony alone became deposited, in small quantity.

17. Salts of nickel and cobalt, added to the basic sulphate of alumina solution, did not asssist the deposition of aluminium.

18. Sulphate of alumina, in a very concentrated solution, to which was added sulphuric acid in a slight excess, failed to give a deposit of aluminium. Fresh additions of the acid were repeatedly made, but with no advantage. Having failed with the neutral solutions, it was determined to try acid baths, but the modification was unsuccessful.

19. A similar experiment was made with a solution of the sesquichloride of aluminium, by adding an excess of hydrochloric acid; the operation, however, was a failure.

20. A quantity of dried hydrate of alumina was treated with hydrochloric acid, and the mixture heated for a considerable time and constantly stirred. After thus digesting for several hours, the resulting mass, which was of a thickish consistence, was allowed to cool and was then electrolysed, a strong current being applied, with a carbon anode and platinum negative electrode. No deposit of aluminium took place.

21. The above mass was next moderately heated, but with no advantage.

22. Sulphate of alumina and sulphate of ammonia solutions in various proportions were also electrolysed, but aluminium failed to deposit from this bath.

23. Sulphate of alumina and sal ammoniac solutions mixed yielded no deposit of the metal.

24. Basic sulphate of alumina, with sulphate of soda in various proportions added, gave no deposit of aluminium.

25. Sulphate of alumina and chloride of sodium in solution were tried, but without success.

26. Neutral sulphate of alumina solution, mixed with a solution of acetate of soda, gave no deposit of aluminium.

27. Phosphate of alumina, prepared by digesting recently-prepared hydrate of alumina in phosphoric acid, was electrolysed, when a bright white metallic deposit appeared upon the negative plate; this was not aluminium, however, but zinc derived from the impure hydrate employed. A solution made from carefully prepared hydrate failed to yield a metallic deposit.

28. Sulphate of alumina and chloride of calcium were made into a bath, but this did not yield aluminium to the cathode.

29. Sulphate of alumina and chloride of manganese were equally unsuccessful.

30. In this experiment the "porous cell arrangement" was adopted. A saturated solution of sulphate of alumina was placed in the outer vessel, and a solution of chloride of sodium and carbon anode in the porous cell; the current was then allowed to pass, and the action kept up for some time; no aluminium, however, was received upon the negative plate.

31. Sulphate of strontium solution was added to one of sulphate of alumina, but the mixed solutions failed to yield up the metal aluminium.

(*To be continued.*)

SEARCH LIGHT ON THE U.S. CRUISER "ATLANTA."

THE recently completed U.S. cruiser *Atlanta* is provided with two search lights of great power, one being located just behind the 8 inch long range breech loading rifle on the forward deck, while the other is immediately back of the stern chase 8 inch rifle. These lights, says the *Scientific American*, are exquisite specimens of mechanism, and, although at first glance they seem to be extremely complicated, there is in reality no part not necessary in order to produce their quick, accurate, and easy universal adjustment.

The tube or cylinder containing the light proper has a length about equal to its diameter, and is mounted upon trunnions placed in bearings in a yoke swivelled upon a post or standard secured to the deck. The tube has a free movement on its trunnions to provide for vertical adjustment, and also moves freely on the pedestal for horizontal adjustment. These movements are accomplished by hand, the operator grasping the tube and manipulating it as may be necessary; but when a fine adjustment is required, the tube is clamped in the bearings and to the standard, when the movement is then controlled by a worm and gear.

Within the tube, the front of which is furnished with a glass door, and in the sides of which are sliding doors, through which the interior can be reached, is an arc light, the carbons of which are three-quarters of an inch in diameter. The arc is located in the focus of a parabolic reflector covering the rear end of the tube, the direct rays being prevented from leaving the tube by a shield held in front of the arc. The carbons are carried by a frame having a movement parallel with the axis of the cylinder, so that the arc can be maintained in the focus. Each carbon is provided with an independent adjusting apparatus, by means of which its point can be moved to either side, forward or back, and up or down. Through the centre of the reflector is an opening, covered by a red glass, through which the arc can be inspected, and at the centre of the right hand side of the tube is a prism. The light can be cut off by a shield, which can be swung down between the arc and reflector. A switch controlling the current of electricity is placed on the pedestal.

These devices for altering the position of the points of the carbons by hand are, of course, independent of the usual mechanism governing the carbons and regulating the arc. They are intended to provide means for shifting and regulating the arc in its relation to the focus.

In the top and bottom of the tube are openings, so covered as to prevent the light from passing out, which serve to ventilate the interior, the heat of the light being sufficient to create an upward draught.

The beam of light issuing from the lantern diverges slightly, and is sharp and well defined. When required, a lens can be fitted over the plane glass cover so as to produce a pencil of light having parallel rays.

It is evident that, from the elevated position of these two lights, their location on the ship, the extraordinary power of the light they throw, and the ease with which they can be handled, the surface of the water immediately around the vessel and at a long distance off can be brilliantly illuminated. The rapidity with which the beam can be swept around and adjusted to short and long distances will serve to give warning of the approach of any floating craft, and any object once sighted can, by means of the delicate adjusting contrivances, be easily and surely kept in the path of the beam. Provision is also made for keeping the light steady during the rolling of the ship.

THE MEASUREMENT OF SELF-INDUCTION, MUTUAL INDUCTION AND CAPACITY.*

By W. E. SUMPNER, B.Sc.

(*Continued from page* 576.)

If the cumulative method be employed, and the readings for different speeds plotted, the points should lie on a straight line. As the zero point on this line is absolutely known, it is possible to get the slope of the line with very great accuracy.

Maxwell's absolute method being thus equally applicable to the measurements of self-induction, mutual induction, and capacity, it seemed very probable that any method of measuring either of these quantities would suggest methods of measuring the remaining two. For that purpose I have traced out an analogy, which is represented in the figures. The first 12 figures show the result of the analysis of Maxwell's methods. The next six figures (13–18) represent the result of an analysis of Fleeming Jenkin's method of determining the capacity of a condenser. Figs. 13, 14 and 15 represent analogous methods of determining the self-induction of a coil, the mutual induction of two coils, and the capacity of a condenser. The coil or condenser is charged by making the battery connection, and discharged through the galvanometer. In the case of mutual induction the alteration of the current in the battery circuit causes a quantity of electricity to rush through the galvanometer, which is a measure of the product of the change of current and the mutual induction. In each case it is necessary to determine the meaning of the swing of the galvanometer, and to eliminate the unknown electromotive force of the battery. This can be done by the same method in each case.

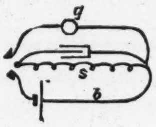


FIG. 13.

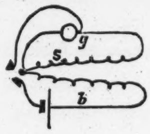


FIG. 14.

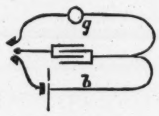


FIG. 15.

If, however, the battery and galvanometer connections are made and broken periodically the effects are accumulated, and the galvanometer will give a steady deflection, which, on being compared with the deflection given by the same galvanometer and battery when a known resistance is in circuit, will render it possible to determine the required coefficient directly in terms of the resistances used, the ratio of two deflections, and the period of the commutator cycle. A ballistic galvanometer may therefore be dispensed with. In the method indicated by fig. 13 a short interval may be allowed to occur between breaking the battery connection and making the galvanometer connection, provided a condenser be used. It is, however, better to dispense with a condenser, and allow a short time to elapse between making one connection and breaking the other, for when the coil having self-induction is suddenly isolated its electro-kinetic momentum will cause the potential difference of the condenser shunted to it to alter almost instantly to many times its original value. In either case, however, a correction will have to be applied to the formula. In the method of fig. 15 an interval may with advantage be allowed to occur between the breaking of one connection and the making of the other. In the method of fig. 14 it is advantageous to make the connection which short circuits the galvanometer before breaking the battery connection.

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* Read in the discussion which followed the reading of Professors Ayrton and Perry's paper on "Modes of Measuring the Coefficients of Mutual and Self-Induction," before the Society of Telegraph-Engineers and Electricians, May 12th, 1887.

As, however, the effect of accumulating all the impulses in one direction is, as far as galvanometers are concerned, to produce steady currents, it is easy to develop these methods into null methods. We have only to shunt part of the battery current continuously through the galvanometer. Figs. 16, 17 and 18 show the result. The battery has to be placed differently in figs. 16 and 18, because a condenser discharges in the opposite way to that of a coil having self-induction. A particular case of fig. 18 is when the resistance, R, shunting the condenser is made infinite. If we suppose the self-induction of the wire, R, to increase, and the capacity of the condenser to diminish, the effect on the galvanometer due to the induction diminishes through zero till, in the limit when the capacity of the condenser is nothing, we have merely the case of fig. 16. The remarks about the commutators of figs. 13, 14 and 15 apply equally to those of figs. 16, 17 and 18. In fig. 17 it is seen that the commutator develops into that used by Profs. Ayrton and Perry.

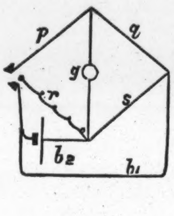


FIG. 16.

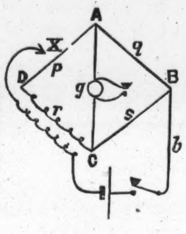


FIG. 17.

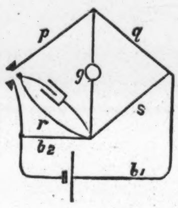


FIG. 18.

In seeking the method of measuring mutual induction analogous to the methods of figs. 16 and 18, it was found that the end, X, (fig. 17) of the battery branch could be placed at any point on the bridge along A D C. Now, if the point, X, be connected with D, we have Maxwell's method; while, if it be connected with C, we have a simple deduction from Professor Carey Foster's method when we accumulate, since, under these circumstances, it is easy to see that the condenser used by Professor Carey Foster is needless. There is, consequently, a close relationship between all these methods, and no one of them is distinct.

Figs. 19–21 show methods for finding capacity and self-induction which are analogous with a method given by Maxwell (Vol. II., sec. 776). Fig. 20 represents a Wheatstone bridge in which one of the arms, A B, is absent, and this absent arm may be supplied by any one of those represented in figs. 20A to 20F. Figs. 19 and 20A represents Maxwell's method of finding capacity (Vol. II., sec. 776)—a method to which he was led by the consideration that if the connections of a circuit with the terminals of a condenser were periodically interchanged, the effect of the capacity would be comparable with that of a resistance. The same analogy led to a method of finding self-induction described in the appendix of the paper of Professors Ayrton and Perry, and represented in figs. 20E and 21. The difference between the two cases consists in the fact that the more rapidly a condenser is commutated the less is its apparent resistance, while the reverse is the case with self-induction. In fig. 20E, if the resistance, Q, of the self-induction coil increases without limit, we have simply Maxwell's method, in which an interval between the reversals is advantageous. If, on the other hand, there is no condenser used, a small short-circuit may be allowed to occur during reversal, and its effect eliminated in the way described in the appendix of Professors Ayrton and Perry's paper. Professor J. J. Thomson (*Phil. Trans.*, III., 1883) gives a modification of Maxwell's method, which consists of breaking the condenser connection and discharging it, instead of reversing its connections. In fig. 20C much the same result is brought about by employing a revolving connector, which short-circuits the condenser during a small fraction of a revolution. The formula will have to include a correction for the short-circuiting the arm, A B, of the bridge while the condenser is being discharged; but this correction need be but very small, for the time constant of the condenser for discharge, being the product of its capacity and the resistance of the short-circuit, is very small indeed, so that the short-circuiting need only last for a very small fraction of a revolution. Figs. 20B and 20D are but extended cases of figs. 20A and 20C. Maxwell's method may be regarded as a special case of the method represented in fig. 20E. Fig. 20F represents a method of finding self-induction somewhat analogous with that of fig. 20C, but it has not yielded good results. There are analogous methods of determining mutual induction, but they are not very promising. In these methods the commutator is in the arm of the bridge. This is no disadvantage in the case of measuring capacity, but it is a disadvantage in the case of self-induction unless the resistances of the bridge are much larger than that of the commutator. The connection of these methods with the preceding is shown by fig. 18. If, instead of discharging the condenser through the galvanometer, the condenser be charged through the galvanometer, we get Professor J. J. Thomson's modification of Maxwell's method.

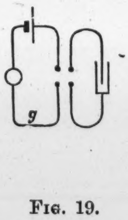


FIG. 19.

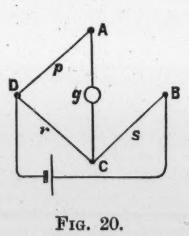
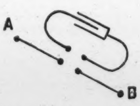


FIG. 20.



20A.

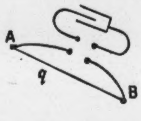


FIG. 20B.

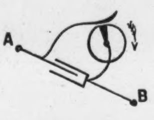


FIG. 20C.

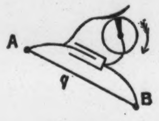


FIG. 20D.

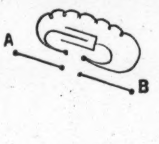


FIG. 20E.

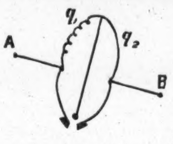


FIG. 20F.

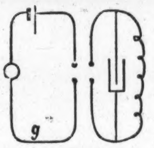


FIG. 21.

Fig. 22 represents a method suggested by Professor Ayrton for determining the coefficient of self-induction of a coil while a particular current is flowing through it. It is but a slight modification of Maxwell's method, and consists in altering by a small amount the current running through the bridge instead of establishing it from zero to its full value. It can be easily shown under these circumstances that

$$L = \frac{C_1'}{C_1 - C_2} \times \frac{\sin. \frac{1}{2}\theta}{\tan. a} \frac{R\,T}{\sqrt{\pi^2 + \lambda^2}} e^{\frac{\lambda}{\pi} \tan.^{-1} \frac{\pi}{\lambda}}$$

where C_1' is the current running through the coil when a derangement, R, of the arm of the bridge in which the coil is placed produces a steady deflection, a, on the bridge galvanometer, and $C_1 - C_2$ is the change of current in this arm which, when the bridge is balanced for steady currents, produces a swing, θ; T is the period and λ the logarithmic decrement of the same galvanometer.

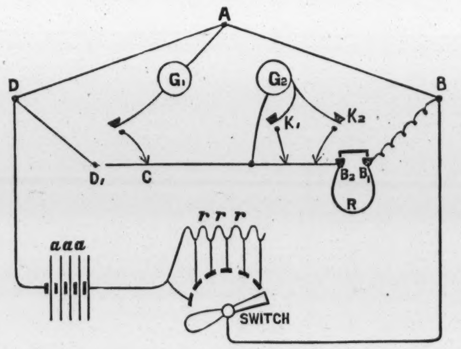


FIG. 22.

The experiments, which were performed with the aid of Messrs. Rossiter and Watney, of the Central Institution, were made on the field-magnets of a Gramme dynamo, and also on those of a Ferranti dynamo. The arms, A, B and A, D, had resistances of about 10,000 ohms each, B, B_1 was the coil whose self-induction was required, D D_1 was a German silver wire of about equal resistance, D_1 B_2 was a very thick German silver wire on which a sliding connector (C) was placed. The D'Arsonval galvanometer G_1 connected A and C through a key. The mercury cups, B_1 B_2, were connected by a short circuit plug, except when the deflection corresponding to known derangement, R, of the arm B C was required. *a a a* are accumulators; *r r r* is a resistance capable of being inserted more or less into the battery circuit by means of the switch, *s*. The currents were changed by moving the switch, and the change of current was read by a second D'Arsonval galvanometer (G_2). By pressing the key, K_1, the galvanometer, G_2, was shunted to a constant length of the wire, D_1 B_2, and measured the current absolutely. By pressing the key, K_2, the galvanometer was shunted to any convenient length of wire, D_1 B_2, and by taking the deflections corresponding with C_1', C_1, and C_2 the ratio $\frac{C_1'}{C_1 - C_2}$ was easily found.

The currents used varied up to 30 ampères, and were sent in both directions. The results show that the coefficient varies with the current, and also with the previous history of the iron. The set of values obtained with an ascending series of currents differs from that obtained with a descending series. The coefficient diminishes rapidly at first, and then more and more slowly. In several cases the results strongly indicate that the maximum value of the coefficient is not that for zero current. This is exactly what it is natural to expect, on the assumption that the self-induction curve is the differential of that of magnetic permeability; for the slope of the latter curve is small at first, increases to a maximum, and then diminishes asymptotically. All the results are, however, much complicated by the fact that the D'Arsonval galvanometer was not sufficiently ballistic. Under these circumstances changing the resistance in the battery circuit alters the time constant of the bridge, although it does not for the same change of current alter the quantity which passes through the galvanometer. The ratio between the swing of the galvanometer and the quantity passing through it was therefore not constant, and the results are therefore not accurate.

This method is equally applicable to the measurement of change of coefficients of mutual induction and capacity. It is not easy to render it accumulative. If, instead of making and breaking the battery circuit, the points, B and D, be periodically shunted and unshunted by a known resistance, it would be necessary to know the resistances in the other parts of the bridge; and this would be difficult if the resistances heat, as they must when large currents are used. In the method just described the only resistance necessary to know was that of R, and this was not allowed to heat.

ON THE DIFFERING TEMPERATURE COEFFICIENTS OF THE DIFFERENT COILS OF A FINE RHEOSTAT.*

By PROF. W. A. ANTHONY.

THE title of this paper should rather have been "A Description of Experiments by which the differing Temperature Coefficients of the Coils of a Fine Rheostat were Discovered." I thought the experiments of sufficient interest to warrant a description, and I find, on writing the paper, that the experiments occupy the greater part of it.

In 1884 the Cornell University ordered of Latimer Clark, Muirhead and Co., of London, a fine rheostat and bridge of special construction. Among other things it was specified that the resistances of the coils of both bridge and rheostat should check among themselves to $\frac{1}{100}$th of one per cent., and that everything should be done to make the instrument as accurate and reliable as it was possible for such an instrument to be. On its arrival it was found not to fulfill the requirements as regards accuracy, the coils differing among themselves in many cases by more than $\frac{1}{10}$th of one per cent. It was returned to the makers for re-adjustment and did not come back to the University for several months. On its return it was found that the adjustments had been much improved, but still did not come within $\frac{1}{100}$th of one per cent. It was, however, finally accepted at a reduced price, the writer proposing himself to perfect the adjustment. Press of other work prevented this being done, and, last November, when a problem requiring the highest attainable accuracy in the comparison of two resistances presented itself for solution, this rheostat was used for making the comparison, it being proposed to afterward determine and apply the corrections for the errors of the individual coils.

The problem was, to find by experiment the ratio of the constants of the suspended and stationary coils of the large galvanometer, a description of which has already been read before the Institute. The constants of these coils were determined by measurement while they were being wound and the experimental determination of the ratio was undertaken as a check on the measurements. To determine this ratio, a current is made to divide between the stationary coils on the one hand, and the suspended coil on the other, but in the reverse direction, so that the two currents shall have a differential effect on the needle. The resistances are then adjusted till the needle is unaffected when the current in both branches is reversed. The constants of the coils in the two branches are then directly proportional to the currents flowing, and, therefore, inversely proportional to the resistances of the two circuits.

To obtain the ratio of these resistances, they were arranged as two branches of a Wheatstone's bridge, as shown in fig. 1, the other two branches being made up from the rheostat referred to above. The apparatus was arranged and the tests made by Mr. Ryan, a senior in electrical engineering, and Mr. Hammon, a graduate student of electrical science.

The first trials showed that nothing could be done with binding-screw connections and sliding contacts. All permanent connections were therefore soldered, and all others made with mercury. After this was done, irregularities still existed which were traced to varying temperatures, resulting from the fact that the building in which the galvanometer is mounted is of wood and warmed by a wood fire in an "air-tight" stove. The fire was allowed to go out, and the work continued at the temperature existing outside, about zero centigrade. Times for the experiments were chosen when the temperature was quite uniform, and the results were found to agree very well among themselves, but, to our surprise, they were totally different from the results obtained at the higher temperatures. The table below will show how the results ran.

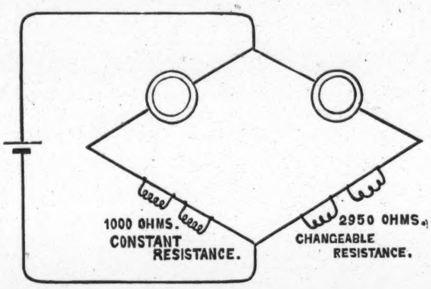


FIG. 1.

Room warmed.		No fire in room		
Temp.	Ratio.		Temp.	Ratio.
21·4	2·9520	Dec. 7	1·7	2·9492
21·3	2·9523		1·7	2·9492
20·8	2·9529		1·8	2·9492
20·3	2·9524		1·6	2·9492
20·2	2·9526	Dec. 8	3·7	2·9495
20·2	2·9528		3·8	2·9498
19·1	2·9529		3·8	2·9497
			3·8	2·9497
			&c.	&c.

Here is a difference of one-tenth per cent. for a change of temperature of about 20 degrees centigrade. It should have been stated that the ratios above are the ratios of the two resistances as read from the rheostat; that one of the resistances was always 1,000, and of the other, which was nearly 3,000, only the units and tenths coils were changed.

A study of the construction of the galvanometer, and a discussion of the effects of temperature upon it, made it clear that the change indicated above could not be a real change in the ratio of the constants of the coils. It must, therefore, be looked for in the rheostat. To test this conclusion, different sets of rheostat coils were used in making up the arms of the balance, and tried at high and low temperatures. In one case the ratio was apparently larger at the lower temperature, the reverse of the result shown in the tables above. But the crucial test was suggested and tried by Mr. Ryan. He took the rheostat out of doors and then subjected the galvanometer and all accessory apparatus, except the rheostat, to changes of temperature. The rheostat then indicated the same apparent ratio for all temperatures of the galvanometer.

It is certain, therefore, that a change of temperature of 20 degrees causes a change in the relative resistances of two sets of coils in this rheostat to the extent of $\frac{1}{10}$th of 1 per cent.; that is, the temperature coefficients of the different coils are not the same, and it is, therefore, no wonder that the makers could not adjust the resistances more accurately. Such differences of temperature coefficients might well occur if the wire of which the coils are wound was taken haphazard from different lots, made, perhaps, from different lots of metal. If makers of fine instruments are not careful to select wire that is sure to be of one composition for the construction of resistance coils, it is no wonder that it is so difficult to attain to a high standard of accuracy in electrical measurements.

But there is another possible explanation for the differences found in this instrument. The low resistances are of coarse wire, and this, from different temper or from different treatment in drawing, might not have the same coefficient, although made from the same metal, as the fine wire. In short, I believe that, for the construction of an accurate rheostat, the coils should not only be from the same lot of metal, but should all be drawn to the same size and subjected to the same treatment while being drawn. The wire chosen should be fine enough for the coils of highest resistance, and coils of low resistance should be made by winding two or more of the same wires in multiple arc.

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* Read at the annual meeting of the American Institute of Electrical Engineers, May 18th, 1887.

Mr. **FRANK L. POPE**: I would like to ask if Prof. Anthony knows of any experiments of that kind that have ever been made with American wire, and whether the same discrepancy is observable there.

Prof. **ANTHONY**: I don't know of any such experiments. It is our purpose to make an investigation of this sort; but this is all I have to report in regard to the matter at present.

Mr. **G. B. PRESCOTT**, Jun.: Prof. Anthony states that the wire in this rheostat was of different sizes. Now, if the current passing through this wire was of the same strength in all the different coils, the tendency would be to heat the thin coils more than the thick coils, and, I suppose, that would need to be eliminated.

Prof. **ANTHONY**: In regard to that, the current was not sufficient to heat the coils anyway. I suppose the current would not have heated the coils $\frac{1}{100}$th of a degree.

Mr. **PRESCOTT**: Some two or three years ago Mr. Edward Weston, with whom I am engaged, was making some fine measuring apparatus, and he found very great difficulty in getting German silver wire at different times that was of a uniform quality. For that purpose he made some experiments on his own account to determine just the nature of this variation and what caused it. What led to his immediately taking up the subject was a paper published a short time previously in England by Prof. Bottomley, who reported the discovery by some Cheshire man of a new alloy which he called platinoid. He said this alloy was ordinary German silver with 1 or 2 per cent. of tungsten added. He showed by some tests that its specific resistance was very much higher and its temperature coefficient very much smaller than German silver. I looked at his original paper, and I could not find what the proportions of the German silver alloy were. I had searched through all the works previously to this on that subject that I could find, and not one of them gave the proportions of this German silver alloy that they used—not even Matthiessen. For instance, you will find in the ordinary tables in the text books a statement of all the different alloys, in which the proportions of each one are given, until you come to German silver, and there they say "German silver," plain and simple. In this country I went to several of the makers of wire and asked for their proportions, and they seemed to use almost everything. After Mr. Weston had heard of this alloy of tungsten, he thought he would investigate it. He made up some ordinary German silver and put some tungsten into it, and kept on adding it until he got 10 per cent., and he found that it did not make any difference. But we found by varying the proportion of the nickel that the resistance could be made almost anything, so that the resistance of the German silver is almost directly proportional to the amount of nickel. The effect of zinc was only that of a diluent; it had a mechanical advantage in making the alloy ductile, so that it could be easily handled. We also found that the temperature coefficient varied inversely; so that the greater the amount of nickel you had, the smaller would be the temperature coefficient. We got results very much higher than had been obtained in England with this alloy called platinoid, which was undoubtedly a German silver alloy with a high percentage of nickel. The temperature coefficient we endeavoured to determine, but we met with a difficulty, which was this: We had a bridge, the largest pattern made by Elliott, the best bridge of any ever made, of very large wire and very few contacts. There is only one contact for a series of plugs. It is called the "dial pattern." We tried to get the temperature of the room very even, and we got some very curious results. We found that the temperature coefficient was in the reverse direction. It decreased apparently after a certain point. But as we never could be certain of the temperature coefficient of our bridge, we were compelled to abandon determining what the exact coefficient of the wire was; but that question of the proportion of nickel increasing the resistance and decreasing the temperature coefficient we proved beyond doubt.

Mr. **MAILLOUX**: I think it would be of interest te have Mr. Prescott state what is the largest specific resistance he attained with various proportions of nickel.

Mr. **PRESCOTT**: In the Western Union Telegraph Company they have a peculiar way of giving specific resistances. It is a very large unit and it is termed the mile-ohm. It is the weight of a wire a mile long which will give just one ohm resistance, *i.e.*, specifies the weight in pounds of the wire. The ordinary German silver on the market has a specific resistance of 12,000 pounds to the mile ohm; that is to say, a wire a mile long having one ohm resistance requires 12,000 pounds of metal. We found by using an alloy of something higher than thirty per cent. of nickel that we got a mile ohm of 38,000 pounds —something more than three times the specific resistance of the ordinary German silver on the market. The temperature coefficient, as I said before, was so small that we could not determine whether there was none at all or whether it was in the reverse direction with the apparatus that we had.

Mr. **WILLIAM WALLACE**: Speaking of German silver, there are all sorts of mixtures on the market, and it does not surprise me at all that you do not get two samples alike. There is another thing. You can take the same mixture and pour it at different heats and get different results from exactly the same mixture. Then you may roll it too much or you may draw it too much, and if you do not anneal it enough, you can pull it apart and you will get all sorts of resistances in that way. German silver is a very uncertain metal to handle. I have made a great many tons of it, and it is very difficult to get two batches alike.

Mr. **J. A. POWERS**: I can speak very feelingly on the subject of the quality of German silver wire in the construction of the McDonald cut-outs, if you will allow me to be somewhat personal. I find that it is almost impossible for us in making those to get wire that will wind twice alike. We wind it up in bands and with a certain definite number of layers. You are obliged to adhere rigidly to a certain routine in order to produce certain results, and all coils are wound up and measured at the same time, and we find that, do the best we can, we will have more or less variations of the wire. We have been to a good many parties for our wire and have been very careful about the gauge, and more careful about the temper, but it still bothers us all the time to get wire perfectly uniform.

Mr. **MAILLOUX**: I can add an item of my own experience on the subject. Very recently I had occasion to use some resistance coils made for an electrical railroad signal system, and the manufacturer showed me two bobbins that he had wound; I think that it was intended to use a resistance of 20 ohms and he was to use No. 18 wire to wind it. He showed me a bobbin which was wound with that resistance and another one on which he said he had to take a No. 20 wire in order to get the resistance. He wound it until the bobbin was full with No. 20 wire, and even then he could not get the resistance. I have no doubt there must have been twice the weight of wire, and of a much finer size than on the other bobbin, where he did not have the 20 ohms necessary. That would show the great difference of specific resistance of the various samples of German silver as we find them in the market, and it would be very desirable to have researches prosecuted on the subject so as to have some definite understanding arrived at which would guide manufacturers in the making of German silver of standard specific resistance.

Mr. **PRESCOTT**: I would say the higher the specific resistance and the lower the temperature coefficient, the better adapted the wire is for use in rheostats. The wire can be handled so that it is not too brittle. All the wire that I have has come from the Coe Brass Company, who made it according to specifications.

Prof. **ANTHONY**: My suggestion is that it would be important in making fine instruments of this sort, not only to use German silver from the same batch, but to take the wire all of the same lot, of the same size, that had been drawn at the same time, and subjected to the same pressure throughout, from the time the metal was melted until it was finally wound up in wire and covered and wound up on the coil, and then to use several of those wires in multiple arc.

Prof. **ELIHU THOMSON**: It occurs to me that this point might be touched—whether in bending a large wire there is not more mechanical energy expended and a hardening or change of the molecules of the large wire since it is wound on the same diameter as the smaller wire in making the coil. We will assume that we have a wire of a certain diameter and compare it with a wire of much smaller diameter. Now in going around a certain arc, the metal on the half of the wire toward the centre will be compressed, while that on the exterior will be expanded, and the amount of compression and expansion, with a certain radius of winding, will be of course much greater in a coarse coil than in a coil of fine wire. This may have some influence perhaps on the point under discussion.

Mr. **MAILLOUX**: I have myself noticed, although I have not the resources of a physical laboratory at my command, that a wire that has been wound and unwound several times has a difference in resistance, especially if it is in large lengths, and I thought at first that I was mistaken, but with very careful measurement I found that there was a slight difference between the two, and I cannot find it to be due to any other cause except some molecular disturbance in the wire.

Prof. **THOMSON**: Take a piece of metal and bend it on edge, and then bend it on the flat, and it seems to be by that means we would arrive at the fact or not of there being a change of resistance produced by bending flatwise and on edge.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND AUSTRALIA.

THE following from the "Australian Handbook for 1887," will probably be interesting to our readers:—Telegraphic communication with the Australian Colonies was established on Tuesday, October 22nd, 1872, when the first congratulatory telegram was received by the Lord Mayor of London from the Mayor of Adelaide.

In April, 1869, a submarine cable was laid between Tasmania and Victoria. In 1876 a cable was successfully laid between New South Wales and New Zealand, and in the course of 1877 the telegraph line *viâ* Eucla, connecting West Australia with South Australia, was finished, thus linking the whole of the Australian group in telegraphic communication with Great Britain. In January, 1880, the laying of a duplicate cable was completed between Banjoewangie and Port Darwin.

The telegraph service to Australia is under the control of the Eastern Extension Telegraph Company, in conjunction with the Eastern Company, Limited, whose offices are at Winchester House, 50, Old Broad Street, London, E.C., whence messages can be sent, marked "*viâ Suez*," or they may be forwarded through the Indo-European Telegraph Company, Limited, offices, 18, Old Broad Street. In the latter case the messages should be marked with the words "*viâ Teheran*," or "*viâ Indo*." Messages can be sent from any of the Post Office stations. The route and length of the astern and Eastern Extension Companies' cables and land lines re as follows :—

LENGTH OF CABLES AND LAND LINES FROM LONDON TO AUSTRALIA.

	Miles.
London to Porthcurno	*338
Porthcurno to Lisbon	846
Lisbon to Gibraltar	368
Gibraltar to Malta	1,118
Malta to Alexandria	925
Alexandria to Suez	*226
Suez to Aden	1,445
Aden to Bombay	1,829
Bombay to Madras	*720
Madras to Penang	1,455
Penang to Singapore	414
Singapore to Banjoewangie	920
Banjoewangie to Port Darwin	1,130
Port Darwin to Adelaide	*2,543
Sydney to Nelson	1,283

Total .. ... 15,560 miles. *Land lines.

From Port Augusta to Adelaide, S.A., the length of line is 196 miles. From Port Augusta the overland wire stretches eastwards to Sydney, N.S.W., a distance of 650 miles. The connection here takes place with New Zealand, the submarine cable commencing at Botany, and terminating at Wakapuaka, a distance of 1,150 miles. From Wakapuaka the overland wire is carried to White's Bay (88 miles), thence by cable to Wellington (41 miles), from which centre, all the towns and cities of New Zealand are communicated with. The Tasmanian cable starts from Flinders, near Cape Schank, Victoria, and terminates at Low Head (Tamar), Tasmania; length, about 176 miles. This cable has recently been duplicated. The duplicate Anglo-Australian cable starts from Penang and thence to Singapore, and Banjoewangie to Port Darwin.

Tariff of Charges.—The Eastern Extension Company's charge for a message between London and the various Australian Colonies, or *vice versâ*, is as follows :—

	s.	d.	
To South Australia	9	4	per word.
„ Victoria	9	4	„
„ New South Wales	9	6	„
„ West Australia	9	4	„
„ Queensland	9	9	„
„ Tasmania	9	11	„
„ New Zealand	10	6	„

The company will register names and addresses. No word must exceed 10 letters. From country stations an additional 1s. has to be added to the foregoing rates. The rates to London from Australia are the same as from it. Reductions have been made in the case of press messages, from 6s. 5d. to 2s. 9d. per word, and for Government messages to 7s. 1d. per word.

Reuter's Telegram Company (offices, 24, Old Jewry) undertakes the transmission of messages at the foregoing rates. The sender's name and address, when registered, is charged—to South and West Australia and Victoria, 18s. 8d.; Queensland, 19s. 6d.; New South Wales, 19s.; and New Zealand, £1 1s. Passengers to Australia can have their arrival announced by telegraph to their friends or relatives at a charge of £1. Reuter's Company has agencies at Melbourne, Adelaide, Sydney, Brisbane, Auckland, Wellington, Christchurch, and Dunedin. With the view of affording facilities for the economical transmission of private telegrams to and from India, Ceylon, China, Japan, Australia, New Zealand, and South Africa, the company has recently introduced a new feature in its telegraphic business, viz., to place its codes at the service of senders, by means of which telegrams may be sent at a considerable saving on the cost of their transmission in plain language. Telegrams so coded will in all cases be translated before delivery to the receiver, to whom a copy in plain language only will be handed. A fixed commission is charged on all messages in addition to the ordinary tariff rate. By this small payment, senders will enjoy the entire benefit of the saving resulting from the use of the company's codes.

In telegraphing between London and the Colonies a knowledge of the difference in time is useful. The following places are in advance of London time by the number of hours and minutes stated. Adelaide, 9 h. 14 m., Auckland, 11 h. 39 m., Bathurst, 9 h. 16 m., Brisbane, 10 h. 13 m., Christchurch, 11 h. 32 m., Dunedin, 11 h. 22 m., Hokitika, 11 h. 24 m., Hobart, 9 h. 50 m., Invercargill, 11 h. 12 m., Launceston, 9 h. 49 m., Melbourne, 9 h. 40 m., Perth, 7 h. 43 m., Port Darwin, 8 h. 44 m., Sydney, 10 h. 5 m., Wellington, 11 h. 38 m.

Communication by cable between Australia and India was maintained without interruption during the year 1885, but on the land section across the Australian Continent to Port Darwin an interruption took place on November 2nd from 3.30 p.m. until 4.15 p.m. the next day. Business on the submarine cable to Singapore was carried on without a break. On September 3rd, 1886, the cable between Java and Rangoon was interrupted for some little time, and on September 13th telegraphic communication between Australia and Europe failed altogether for a short time. To prevent any interruption by the failure at any time of the overland line it has been strongly recommended that a connecting land line should be constructed between Normanton (or the nearest station in Queensland) to Port Darwin, or between Normanton and the most convenient point of junction on the overland line, probably Daly Waters or the Catherine. In 1885 it was proposed by the Eastern Extension Australasia and China Telegraph Company to lay a cable between Normanton and the Roper River—along the western shore of the Gulf of Carpentaria, a distance of about 450 miles. From the Roper River the line would be carried overland to Elsey Creek (about 150 miles), situated about 300 miles from Port Darwin, between Daly Waters and the Catherine.

It has also been proposed to lay a telegraph cable between Java and Thursday Island.

During 1885 there were received in Australia by the European telegraph 23,206 messages, of the value of £131,868 0s. 10d. There were transmitted, 24,003 messages at a cost of £144,682 19s. 2d.; a total of 47,209 messages of the value of £276,551. The number and value to each colony were :—Victoria, messages transmitted 6,830, value £43,429 6s. 5d.; messages received 7,447, value £42,376 11s. New South Wales, messages transmitted 8,000, value £50,028 12s. 6d.; messages received 6,616, value £39,557 2s. 8d. New Zealand, messages transmitted 3,435, value £23,021 9s. 10d.; messages received 3,178; value £20,304 3s. 8d. South Australia, messages transmitted 3,132, value £15,621 2s. 9d.; messages received 3,925, value £19,973 12s. Queensland, messages transmitted 1,818, value £9,799 13s. 7d.; messages received 1,324, value £6,895 7s. 2d. Tasmania, messages transmitted 393, value £1,559 7s. 1d.; messages received 354, value £1,394 0s. 10d. Western Australia, messages transmitted 395, value £1,223 7s.; messages received 362, value £1,367 3s. 6d.

In December, 1878, the negotiations that had for some time before been proceeding for the duplication of cable communication were brought to a successful issue, and as mentioned before, the cable has been laid, and has on the whole worked satisfactorily.

The articles of agreement between the Eastern Extension Telegraph Company and the representatives of the Australian Colonies were signed in London on May 6th, 1879.

The principal features were that the company, for an annual subsidy of £32,400, continued for the term of 20 years, should construct a second cable from Penang to Singapore direct to Banjoewangie, and thence direct to Port Darwin, and maintain the same and its connections in working order. In consideration of this subsidy the company were to allow a rebate on Government messages of 2s. 10d. per word; and also upon press messages exchanged between England and Port Darwin of 4s. 3d. per word, such reduction not to be extended to any Colony other than such as may contribute towards the subsidy. The company, during the currency of this agreement, was not to increase its own proportion of the charges for messages exchanged between Port Darwin and London beyond the rates provided for. The Colonial Governments were to have the right during the currency of the subsidy to purchase the company's cable, lines, and other property between Singapore and Port Darwin on equitable terms, to be fixed, in case of difference, by arbitration; 12 months' previous notice to be given to the company of the intention to exercise this right; this right not to be exercisable till the company shall for five years have paid a dividend equal to 10 per cent. per annum, or shall for that period have passed 10 per cent. per annum to its reserve or other accumulated fund. In the case of total interruption of telegraphic communication between Singapore and Port Darwin, arising otherwise than by reason of war or any such-like cause, a deduction to be made at the rate of $\frac{1}{365}$th part of the subsidy of £32,400 for every day exclusive of that on which the interruption occurs.

The contributing Colonies to the subsidy are New South Wales, Victoria, South Australia, and Western Australia. New Zealand has ceased to contribute, and Queensland declined to contribute on the ground that the cable was no real duplication, but simply took the place of the old cable, whose working had been unsatisfactory. A new adjustment of the subsidy, which is divided on the basis of population between the Colonies is at present in operation, as follows :—New South Wales, £12,617 1s. 4d.; Victoria, £14,478 13s. 10d.; South Australia, £4,805 9s.; Western Anstralia, £498 15s. 10d. At the Postal Conference held at Sydney in May, 1883, it was agreed that the basis of population should be taken to include the aboriginal inhabitants of the respective Colonies. The next adjustment of the subsidy to be paid will be made after the census returns have been ascertained. A continuous day and night service is now established between London and Adelaide.

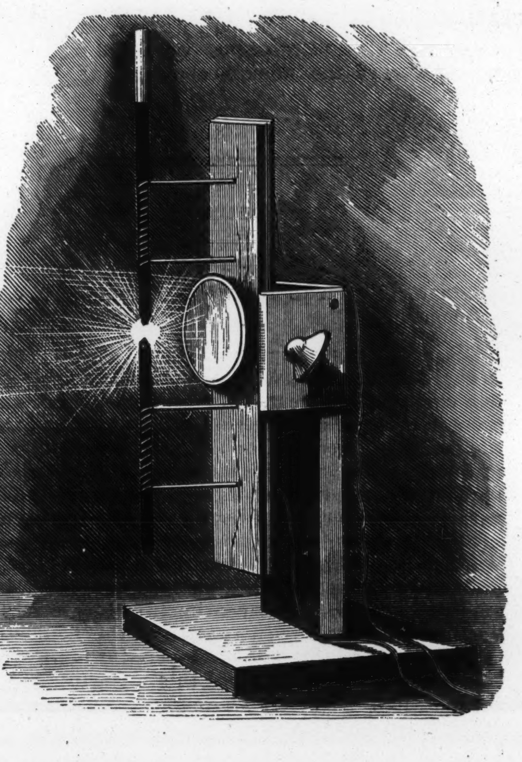
The cable has been specially manufactured, the core being protected from the attacks of marine insects by a brass tape, and each of the external wires is protected, first by an adhesive mixture, then by a patent tape, the whole again protected by two coverings of tape. During 1884, 420 miles of new cable in one continuous length, from Port Darwin over the Sahul Bank, was laid, replacing a similar length of old cable. The core of the new cable is sheathed in brass ribbon to prevent if possible the destructive ravages of the teredo.

Before the duplicate cable was in existence, messages between London and Melbourne averaged from 12 to 24 hours in transmission. A message often reaches its destination now in from 3 to 6 hours, and telegrams have been sent from Melbourne to London, and *vice versa*, and replies received on the same day. The average time occupied in the transit of messages by the Indo-European Telegraph Company is stated to have been, to Australia 5 hours 38 minutes, to New Zealand 7 hours 30 minutes. During 1885 several of Reuter's telegrams were received in the Melbourne *Argus* office in 1 hour 58 minutes after their despatch from London.

INEXPENSIVE ARC LAMP.

FOR most experimental uses, and for practical use in connection with the projecting lantern, a simple and inexpensive arc lamp described by Geo. H. Hopkins, in the *Scientific American*, serves a very good purpose. It requires an occasional adjustment of the carbons to maintain the arc; but this is a matter of little consequence if the lamp is used for a purpose requiring the constant presence of the operator in its vicinity. Should the arc be broken, it may be re-established instantly without careful adjustment of the carbon rods. As will be seen by reference to the engraving, the lamp requires little skill or time for its construction, and the materials of which it is made cost practically nothing.

The experimental lamp shown, consists of two stout copper wires, each bent to form a helix of sufficient size to readily receive the carbon rod and permit of turning the rod for the purpose of feeding it forward to maintain the arc as its point is consumed. The straight ends of the wire extend in the same direction at right angles to the helix, and are offset and inserted in a board and bent down upon the under side of the board. The two helices are arranged axially in line, so that the points of the carbon rods will centre accurately, and each helix is bowed at its centre to secure a spring contact with the sides of the rod.



The outer ends of the rods are inclosed in short pieces of rubber tube, to prevent an electrical contact of the fingers with the rods. This simple lamp has been found very useful in experiments in connection with the eight-light dynamo, recently described in these columns. When this lamp is used in connection with a small dynamo like the one referred to, or with a battery, no particular care is necessary in handling it, but it should be used with caution in a circuit conveying a very heavy current. When used in connection with the eight-light dynamo, the carbon rods should be $\frac{5}{16}$ths inch in diameter. By turning one or the other of the rods in the helix, it is moved forward or backward, according to the direction in which it is turned; the friction of the carbon in the helix giving the carbon the motion of a screw in a nut. When the arc is broken, it is unnecessary to screw the rod forward and then retract it, to re-establish the arc, as the wire will spring sufficiently to permit of pushing the rod forward to bring the points in contact, and the resilience of the wire will return the carbon to its normal position, thus establishing the arc.

The lamp is adapted to lantern use by grooving the edges of the board and mounting the board between clamping pieces attached to a standard and provided with tongues fitted to the grooves of the board, a screw being inserted in the clamping pieces for drawing them into contact with the edges of the board, as shown in the fig. A small concave reflector is attached to the centre of the board, to reflect the light which would otherwise be lost.

The clamping device permits of centreing the reflector, and the arc is retained opposite the centre of the reflector by the occasional adjustment of the carbons.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 563.)

WATTMETERS.

NEARLY all wattmeters, or instruments for measuring electrical power, are modifications of Weber's dynamometer, in which a fixed coil produces a field and tends to turn a movable coil. Electrometers are occasionally used, especially in alternating current work. The best known wattmeter is Siemens's dynamometer wound specially with one fine wire coil, which is put in shunt to the part of the circuit in which the power is to be measured, and a thick wire coil which is put in series. The force is then proportional to the product of the currents in the two coils, that is, to the product of the electromotive force and current, or to the power. This instrument has the same advantages and faults as the Siemens dynamometer voltmeters already described.

In addition to these they have an error which exists in all wattmeters on the Weber dynamometer principle. Suppose the power spent in a lamp is to be measured. If the fine wire or pressure coil is put in shunt both to the lamp and current coil, the current through it is proportional to the fall of potential in the lamp and current coil; and if the pressure coil is in shunt to the lamp alone, it must be in series with the current coil, and the current in the current coil is not the same as that in the lamp, but has the sum of the currents in the lamp and pressure coil. As the pressure coil generally takes more power than the current coil, it is best to put it in shunt to the lamp and current coil. This error may be very considerable. Suppose, for instance, that the fine wire is in shunt to the lamp only, and that its resistance is 500 ohms. Suppose two lamps are to be measured which require 50 watts each, taking 100 volts and ·5 ampères, and 50 volts and 1 ampère. With the 100 volt lamp the pressure coil will have ·2 ampère, and the current coil ·7, the product representing the force will be ·14. If the 50 volt lamp is measured the pressure coil will have ·1 ampère and the current coil 1·1, and the product will be ·11. Thus if the wattmeter is right with the 50 volt lamp, it will be no less than 27 per cent. wrong with the 100 volt lamp. With smaller lamps the error will be still greater. When the power to be measured is very large in proportion to the power absorbed by the instrument itself, the error is negligible, but wattmeters are most generally used for incandescent lamp work, for which they are generally unfit.

The writer has introduced a method of winding which eliminates this error. If the fixed coil is the pressure coil it is arranged in shunt to the lamp and current coil. A few turns of wire are arranged in shunt to the pressure coil so as to subtract from its field an amount equal to that due to the resistance of the series coil. The field due to this compound pressure coil is then proportional to the difference of potential of the lamp terminals, though there may be an additional fall in the thick coil itself. It is best to have the current coil fixed, however, for several reasons. It is easier to make connection with a coil carrying a small current; and it is difficult to make a shunt to a low resistance coil with mercury cups or other connections which will always preserve the same relative resistance. If the current coil is fixed, the pressure coil is arranged in shunt to the lamp only, so that the current coil carries the pressure coil's current in addition to its own. As many turns as there are in the current coil are then wound backward round it and put in series with the pressure coil, so that when the lamp is removed so as to give a difference of potential without current through the lamp, the index is not moved.

A properly compensated wattmeter should give no deflection when there is a large current and no electromotive force, that is when the instrument is set to measure the power in a short circuit, so that the pressure coil only has a current if it is in shunt to the current coil; and it should give no deflection when there is electromotive force and no current, that is to say, when it is set to measure the power in an open circuit, so that there is no current in the current coil unless it is in series with the pressure coil.

Profs. Ayrton and Perry have brought out a wattmeter. It is a dynamometer, but has the advantage of being direct reading. It is made by Messrs. Paterson and Cooper, price £15 15s.

Meters.—These may be divided into energy and quantity meters. In an incandescent lamp installation, for instance, the electromotive force is, or ought to be, kept constant, so that a meter which measures the total quantity of electricity in meg-coulombs will serve the purpose just as well as one that gives the energy used or work done in meg-joules or horse-power hours. On the other hand, if the consumer is running motors with varying loads, and the electromotive force in the mains is not kept constant, an energy meter is required.

The most obvious way of measuring the quantity of electricity is by means of voltameters. If the average current is large a voltameter cannot be put in the main circuit, as it would waste too much power and would be too bulky. Mr. Edison places little voltameters in shunt to a small resistance in the main circuit. The plates are zinc, in a neutral solution of zinc sulphate. A resistance of German silver is inserted in the main circuit, and the voltameter is put in shunt to it. A resistance is in series with the voltameter.

These meters have been in extensive use in the States for some time, but they are little known in this country. One would expect some difficulty in making such meters accurate. If the meter and its circuit is put in shunt to a high resistance, so that there are two or three volts on the voltameter circuit when the house is using say, 50 lights, there will be an excessive loss of power in the meter resistance amounting to 2 or 3 per cent. of the whole power used. The loss of power is not the worst, the loss of electromotive force due to the resistance makes the lamps burn dull and the light, which is what the consumer pays for, is diminished seriously, so that the meter may itself be the cause not only of what amounts to an error of 10 per cent., but also of a dead loss of 10 per cent. of the light. The insertion of resistance in the main house-circuit is therefore to be carefully avoided, as it reduces the available electromotive force just at the time when it is likely to be low owing to the resistance of the street mains. If, on the other hand, the voltameter is put in shunt to a very low resistance, the electromotive force on the voltameter circuit is too low when only a few lamps are on, and the least back electromotive force set up in the voltameter cell will cause large errors. The voltameter cell has a resistance in its own circuit, so that any electromotive force in the cell itself causes as small an error as possible. Voltameters are said to give inaccurate results because of slight differences of density in the solution or of materials in the plates, which give rise to local currents when there are no lights on, and the cells are practically short circuited through low resistances. This is probably the case, more especially with copper voltameters, and Mr. Edison has given up the use of copper, perhaps for that reason.

Mr. Wright uses small copper voltameters in the Brighton installations. The lamps are arranged in groups of eight or three, and each group has a cut out wound with high resistance wire to put in a new lamp if one of the group is broken. A little copper voltameter is put in series with the high resistance coil, and the time the consumer has used each group of lamps is thus known. The consumer, of course, short circuits a group out when he does not want it.

M. Faure has devised a meter in which the wire carrying the current is made to rotate round a pole of an electromagnet. The torque was supposed to vary as the square of the current, and the speed of revolution was supposed to vary as the square root of the torque, so that the speed was as the current. The number of revolutions was counted, so that the meter read in coulombs or ampère hours. The rotating wire made a contact every revolution, putting an electromagnet into circuit. This electromagnet worked a ratchet wheel, which worked the index mechanism.

(*To be continued.*)

REVIEW.

Practical Directions for Winding Magnets for Dynamos. By CARL HERING. London: E. & F. N. Spon, 1887.

The above work largely consists of papers published in the *Electrical World* of New York, and reprinted in our columns last year. We cannot say that any progress in dynamo construction is here indicated, most of the methods described for the practical determination of the field magnet windings being already well known to electricians. Since the papers were published periodically a very considerable advance has been made in this direction, with the result that they are now, when published in book form, rather out of date. The method of computing the strength of field by the ampère-turns per square centimetre of core section is wholly erroneous, the conception of the field strength as depending on the ratio of ampère-turns to magnetic resistance having condemned this mode of looking at the question. Mr. Hering's way of designing, it seems, is to construct a machine "on spec.," and see how it turns out. "If the depth of the coil is too thin," he naïvely remarks, "there is more iron in the core than is necessary, or the magnets are too long, or both; if too thick, the magnets are probably over-saturated or too short, or both." Quite so, we agree with Mr. Hering; but on this side they are not built that way. We prefer to spend a short time in making a calculation which, if it does not lead to results quite accurate, gives us the true excitement required within a small percentage. That Mr. Hering's method would have done very well a short time ago we do not deny, but that time has now, we hope, gone by.

The author's ideas regarding the proper density of current to be carried by different sections of wire are very unscientific. The temperature does not depend on the density of the current but on the ratio of the work done in the coils to their radiating surface. It may be that the density of current is similar in many dynamos of different type, but this is simply accidental, and in designing machines it is the above ratio that should be looked to. Mr. Hering fixes the density of current, but he also fixes the thickness of the coil as a function of the magnet thickness. This is obviously wrong, for if the density is constant the thickness of the coil (neglecting the value of the ends for radiation) must also be constant if all the magnets are to be raised to the same temperature. Mr. Hering would raise the temperature of the larger magnets far above the smaller, but a little reflection will show that with a fixed density the thickness of the coil is quite independent of the size of the cores. Why Mr. Hering turns all his curves upside down we don't know, but to the ordinary reader it is rather confusing, and they might as well be drawn in the orthodox way as not. We would be inclined to modify Mr. Hering's method of determining the series windings for compound machines, but the space at our disposal will not permit us now to enlarge upon the subject. Imagining that the book is written more for the workman than for the expert, there is a good deal to be learnt from it if only in the method of experiment, and we think it might be read with advantage for this reason.

A CELEBRITY ABROAD.

THERE is only one great man in France, and his name is Herz—Dr. Cornelius Herz, Grand Officer of the Legion of Honour, Officer of Public Instruction, and Correspondent of the Ministry of Public Instruction and Fine Arts of France. The greatest men are not always the best known, and it is possible that there are Frenchmen still alive whose names, even amongst our own readers, are more widely known and revered than that of Dr. Herz. Great men are proverbially modest, and, confident as they may be that they stand upon an altitude higher than that occupied by those around them, they invariably wait until others recognise their genius before uttering even a whispered intimation that they are not as other men. Thus, if their friends and intimates be undiscriminating, or envious of powers greater than their own, there is danger of the self-consuming genius descending to the grave unhonoured and unsung, his best and noblest qualities never known or never acknowledged. Of course there is the chance of accident; and to accidents and fortunate happenings we owe much of the wisdom and many of the benefits which the world has derived from its most gifted offspring, for but for those accidents and happenings the minds of these benefactors of their fellow men would have remained undeveloped or would have been condemned to labour in ignoble paths. Whether it is to accident or to growing and gradual appreciation that Dr. Herz owes his present fame is to us unknown. But the discovery that he is a man among men seems to have been quite recently made. If we are to credit the gossip papers, the distinguished electrician has had many friends, men of note in the political world and leaders in the world of letters; yet none of these detected flowering genius in the "robust, keen-eyed, broad-browed man" who was continually inviting them to witness interesting electrical experiments which seemed to lead—nowhere; or if they perceived it they held their tongues, lest, perhaps, their own fires should pale and grow hopelessly ineffectual in the light of the new sun. To a correspondent of the *Times* belongs the honour either of being more discriminating than any of his fellows or more honest and outspoken on his friend's behalf. Backed by the immense influence of the organ which he represents in Paris, that gentleman has published to the whole world what was before known to comparatively few—the marvellous inventive faculty possessed by Dr. Cornelius Herz as exemplified in the production of—the micro-telephone push-button! With their usual perspicacity, the celebrity hunters and the men who seek "the coming man" in the interests of the hebdomadal society papers, have followed the lead of the *Times* representative and have sought the hospitality of the Avenue Kléber. *Truth*, a week or so ago, waxed eloquent over the fact of the discovery of Boulanger, the most popular man in France, by Herz, the cleverest man in France; and now the *World* is adding its mite of panegyric to the art collector, the *savant*, and the man. Thus it will be seen that if newspaper eulogy can confer distinction, Dr. Herz is on the high road to that fame which is the coveted ambition of most men, great or small. A great deal comes to the man who watches and waits, and makes the most of opportune occasions; and this French-American scientist possesses in superabundance the qualities which assist destiny. He is a man of unbending energy and will, says the admiring *World*, also he possesses the prime quality of enthusiasm, which in any man goes far towards impressing others with faith in his abilities and in his undertaking. It is true that the man has been enthusiastic over several schemes which have been close approaches to failure; but these miscarriages have been made to look so much like partial successes that many people are altogether deceived as to the real character of the result.

Herz believes in himself, we are told, and we are quite prepared to accept the statement as a correct proposition: he believes in his power to impress, to persuade, and to put the right colour and construction upon any matter of doubtful import; in fact, he believes firmly in his own ability to be plausible. Another dictum from the same source we are a little more chary in accepting, namely, that he believes in everybody else. The attribute of such extreme simplicity is scarcely to be found in the travelled Parisian who is at the same time the bustling American, alert and perceptive. Perhaps the reason why he is credited with such an abiding confidence in humanity is that he knows how to judiciously flatter the understanding of those with whom he comes into contact by assuming an air of child-like faith and belief in the wisdom of the least significant utterance. This undoubtedly gives him power, for men are alarmingly prone to be gulled into the belief that they are oracles, and that their hearer never doubts that he is listening to the uttered thoughts of a great intellect. But the mystery is that after the connection of Dr. Herz with so many exploits which have come to nothing, there should still be found ardent admirers of his genius. Those who were witnesses of his enthusiastic championship years ago of the Werdermann semi-incandescent lamp must ever since have been expecting a little revolution. Marvellous were the prophecies and promises emanating from the Yankee Frenchman when he had to do with that invention—but the fantastic visions conjured up as the certain outcome of this highly lauded scheme were never realised. Well do we remember how on more than one occasion we incurred the Doctor's wrath by venturing to question the practicability of the manifold ideas with which his fertile brain was teeming. But the event in each instance proved the justness of our criticisms, and we doubt if many people are richer, though many must be wiser, as a consequence of the "soft and suave" influences brought to bear upon their reasoning faculties by Dr. Cornelius Herz.

More recently we have become accustomed to his strong advocacy of Marcel Deprez's power transmission schemes, which, again, were to take knowledge on a flowing tide far, far above the previously existing high water level. But what have we seen? Notwithstanding the ungrudging support of the Rothschilds and the concomitant lavish expenditure of gold, we are pretty much where we were, and the only knowledge we have gained from Marcel Deprez's experiments is that a great deal of money may be spent to very little purpose—and even that many persons will fancy they knew before.

Coming to the latest and most notable of Herz's wonderful discoveries, the *bouton telephone*, we have no hesitation in saying that so far as the apparatus is concerned there is but little of invention in it. Ten or twelve years ago telephones of a similar kind were constructed in the British Telegraph Manufactory; those little telephones were even more simple, inasmuch as transmitter and receiver were one and the same instrument, the microphone being absent. They were worked magnetically, that is to say, precisely as were the first Bell telephones. The motives of the *Times* correspondent and the interviewer of the *World* may be of the purest, but that those eminent journalists should have been so readily convinced of the greatness of the man and of the wonderful nature of his so-called invention, is but an instance of how gullible otherwise well-informed people are in regard to matters which are just beyond their ken.

NOTES.

Electric Lighting in Chili.—A commencement has been made at the port of Coquimbo, Chili, in electric lighting, Edison's system being employed. The dynamos, machinery and other plant required for the installation, we learn from *Industries*, have been procured from the United States. Mr. J. Grierson, the British Consul at Coquimbo, thinks that if the experiment proves successful neighbouring localities will follow suit.

Electric Lighting in Madrid.—A large electric light station is projected in Madrid, a plot of ground having already been selected for this purpose in one of the outlying districts, from which, says *Industries*, it appears that it is intended to use the transformer system. The motive power will amount to 2,500 H.P.; the engines being of English make, and Naeyers or Belleville boilers being employed. The dynamos will probably be from the Oerlikon works.

Electric Lighting of the National Liberal Club.—The grand edifice on the Thames Embankment which is to be the future home of the National Liberal Club, is lighted by electricity. There are several circuits to provide for the partial lighting of the large rooms, and in the smaller rooms each lamp is under separate control. Edison-Swan incandescent lamps are used.

Electric Lighting Tenders.—For repairing the electric lighting installation of the Brighton Pavilion tenders may be sent to the town clerk, Town Hall, Brighton, by 10 a.m. on the 25th inst. Tenders are invited (up to the 25th inst.) for the lighting of the streets of Alford by gas or other light up to May 14th, 1888. Particulars may be obtained of the clerk to the Inspectors for Lighting, West Street, Alford.

Electric Lighting in Greenock.—"R." writes from Greenock:—"With reference to the note from the *Gas World*, which appeared in your issue of 27th ult., permit me to state that the electric light was discontinued solely on account of the heavy charges for lamp renewals."

Proposed Electric Lighting at Exeter.—The widespread movement in favour of the electric light is making itself felt at Exeter, where a proposal is on foot to carry out some experiments by way of showing the public what results can actually be achieved. It is understood that a company has got the matter in hand, and are only awaiting the sanction of the Town Council before commencing operations. Water might be used as a motive power for the dynamos, but there appears to exist considerable doubt as to whether the city is sufficiently progressive in its instincts to render any electrical enterprise which may be attempted a complete success.

The Electric Light at Portsmouth.—In connection with the Jubilee illuminations at Portsmouth, which were carried out on a very large scale, the electric light was utilised to considerable advantage. At the Theatre Royal there was a special installation, and a large arc lamp was suspended in a prominent position above the entrance. Messrs. J. D. Antill and H. Bishop also displayed the electric light, which served to add additional brilliancy to the decorations.

The Jubilee Illuminations.—The electric light was employed in many parts of London for the purposes of illumination on Tuesday night, but perhaps not quite so largely as might have been anticipated. Wherever it was to be seen it was conspicuous and won admiration. It is unnecessary to go into details of the numerous temporary installations, but a few of the most noticeable uses to which the light was put may be mentioned. First of all, what perhaps attracted most attention and interest, was a search light in Leadenhall Street, manipulated so as to throw electric beams great distances, first in one and then in other directions. Of set illuminations, that carried out by the Anglo-American Brush Company at the Institution of Civil Engineers was very effective, consisting of a number of glow lamps on a white background. Here 530 lamps of 10-C.P., were arranged, two in series, so as to form the legend "1837—1887. Her Most Gracious Majesty the Queen." A Victoria dynamo, driven by a 20-H.P. portable engine supplied the current. The illuminations in Mecklenburgh Square, were perhaps as good as any in London. Two arc lamps of 3,000 C.P. each were suspended 30 feet up in the trees, and thousands of coloured lights and Chinese lanterns were very largely employed. The arcs were run from accumulators. Mr. C. J. Phipps's house looked very pretty with the incandescent lamps shining from within. Mr. Rashleigh Phipps, we believe, carried out the illuminations here. At the School of Electrical Engineering, Princes Street, Hanover Square, the students fitted up a loyal device in incandescent lamps set in white cotton wool. Similar devices on a larger scale were exhibited at the First Avenue Hotel and at the offices of the Prudential Assurance Company and looked quite charming. In Bond Street the Grosvenor Gallery was conspicuous. From the centre of the roof rose a mast 40 feet high. Encircling this mast near the top were suspended four powerful arc lights. From wires run from the upper story across the street were suspended 50 powerful incandescent lamps, and from the centre of this group was suspended a medallion containing two photographic transparencies of the Queen. The whole gave the appearance of an immense necklace, with a locket or pendant attached.

The authorities of Ely Cathedral arranged with Messrs. Crompton to illuminate the top of the tower with an electric arc light of some 6,000 candle-power. This was visible over the Isle of Ely and other parts of Cambridgeshire, from Wisbeach on the north to Cambridge and beyond on the south, from Peterborough on the west to Brandon and Suffolk on the east. Lincoln Tower was similarly lighted.

Bridge Lighting in Chicago.—The Mayor of Chicago has recommended, in a communication to the City Council, a plan for the abatement of the "bridge nuisance" in that city; the plan is that proposed by Prof. Barrett, to light the river at night by electricity, and keep the bridges open from 12 o'clock midnight to 6 in the morning, except closing them at intervals of an hour for a few minutes, and keeping them closed during the day, except in case of storms, when a limited authority will be given to open them. An estimate of the cost accompanies the communication in which the use of 100 double-carbon lamps is recommended. To operate these, four 30-light dynamos would be required, and an engine and boiler of 125 horse-power. The cost of such a plant is placed at $47,750, and the annual cost of operating at $10,165, including 6 per cent. interest on the cost of the plant. The council now has the matter under consideration.

Lighting Tricycles by Electricity.—At Portsmouth, last week, a rather novel use of electricity was attempted with the result that at a run of the Southsea Tricycle Club, Mr. Izod, the captain, rode a machine lighted by means of a small incandescent lamp, contained in an ordinary box, fitted with a bright reflector. The experiment was a success, the light being found to be extremely penetrating.

Electric Lighting in Austria. — The Thomson-Houston Company of Massachusetts has established an agency in Vienna which is now engaged in arranging with a local firm for the manufacture of Thomson-Houston machines, lamps, and other apparatus. Patent litigation in respect of glow lamps, states *Industries*, has now also commenced in Austria. Up to the present, the lamps manufactured there were of the Lane-Fox pattern, the Bernstein pattern, and a lamp made by Messrs. Egger & Co., and no opposition from other patentees was offered. But recently the Swan Company brought an action against Messrs. Ganz & Co., with the result that the former have established their right to use Swan lamps throughout Austria-Hungary. The central electric light station in Salzburg is being pushed forward with great activity, and most of the conductors in the streets are already laid. These cables were made by Messrs. Siemens and Halske, and are of specially high insulation. The import duty which had to be paid for these cables amounted to the extraordinarily high figure of £20 per ton.—The Municipality of Vienna has offered to give the concession for the establishment of an electric light station in the centre of the town to Messrs. Siemens and Halske for 30 years only, and they also demand 3 per cent. on the gross receipts, and reserve the right of allowing other electrical undertakings in the same district. Messrs. Siemens have accordingly informed the Mayor of Vienna that they cannot agree to these conditions. They count, however, on a considerable private business, and have erected in Vienna a large branch establishment, from which they will supply all the requirements for electric lighting to their Austrian customers. They also intend in the near future to manufacture dynamos, lamps, and cables in Austria, a policy which is almost rendered imperative by the high tariffs which came into force on the first of this month. At the present moment there is no factory in Austaia where cables are made outright, although there are the works of Herr F. Tobisch for the covering of wires and cables, and the works of M. Choudoir for the covering of cables with lead.—Herr Sellner, a naval officer, has constructed an arc lamp for signalling on board vessels. The current to this is supplied by a Parsons steam turbine and dynamo running at 900 revolutions per minute.—Petroleum motors are coming into use for electric lighting purposes, the well-known mechanician, Herr Siegfried Marcus, of Vienna, making a speciality of these motors. They are manufactured to his designs at Adamsthal, near Brünn, and at Elbing (Germany). At the latter place, some motors for 240 H.P. are in course of manufacture.

Owing to the operation of the new tariff which came into force in Austria on the 1st inst., special precautions will be necessary in the importation of dynamos. As the tariff now stands, these machines, if imported complete and ready for work, will have to pay a duty of £24 per ton, the duty being calculated as if the whole of the weight were made up by cotton covered wire. Such a duty would evidently be prohibitive, and to avoid it foreign manufacturers are permitted to import dynamo machines in parts, when each component part will be charged the duty according to the material preponderating in its construction. Machinery and apparatus containing by weight 75 per cent. of wood, pay £5 per ton; machinery and apparatus containing over 50 per cent. of base metals other than iron or copper wire, pay £15 per ton; other portions of machinery not containing wire, pay £8 10s. per ton. If machinery is imported in parts which require to be finished before being fitted up, it is taxed at a slightly reduced rate as compared to the above.

International Telephony.—The second telephone line to be erected between Brussels and Paris will be attached to the existing telegraph posts, but, according to *Industries*, will be carried by a different route to the first line, which was taken *viâ* Mons, Quévy, and St. Quentin. The new line will follow the railway by Baulers, Marchienne, La Sambre, Thuin, Beaumout, Chimay, Vérviers, Laon, and Soissons. The total length of line is 211 miles, of which eighty miles are in Belgium. The Paris-Brussels line will shortly be extended to Antwerp, and it is also intended to join Antwerp and Havre. In the meantime it is impossible to connect Antwerp with Rotterdam, Amsterdam, and the Hague, as Holland has no laws for the regulation of telephone lines.

The Telephone in Spain.—We hear that it is proposed to establish a telephone line between Madrid and Barcelona.

The Electric Light in the German Army.—German regiments on a night march will in future be preceded by a waggon carrying a powerful electric light, by which, it is claimed, the road ahead can be seen, and the danger of surprise by an enemy considerably lessened.

The Telephone at Johnstone.—On Wednesday the National Telephone Company opened an exchange in Johnstone, so as to provide increased facilities for the subscribers and the general public. The telephone company extended its system to Johnstone some twelve months ago, but the increase of subscribers and the importance of the town has made it necessary that an exchange should be established. The new exchange has been constructed on the premises of Bailie Hunter, at Houston Square, that gentleman having been appointed the company's agent for Johnstone and district.

Telephonic Connection between Hamburg and Bremen.—Last month telephonic communication was opened between Hamburg and Bremen, and now a line is in course of being laid down between the former town and Kiel, with an ultimate extension to Flensburg. The telephone net of Hamburg, which in 1881 was 920 kilometres in length, was, previous to the extension to Bremen, 2,950 kilometres. Adding this—112·8 kilometres—and the line to Kiel and Flensburg, 113 kilometres and 78·8 kilometres respectively, Hamburg will soon have a telephone net of 3,254·6 kilometres.

The Telegraph Companies and the Press. — The *Journalist* of last week gave a portrait and biographical sketch of Mr. William Saunders, the founder of the *Western Morning News* and of the Central Press, the predecessor of the present Central News Agency. With reference to the circumstances which led to the formation of the Central Press, the *Journalist* gave the following interesting particulars: "Soon after the *Western Morning News* was commenced, a circumstance occurred which had an important bearing upon current events. The Budget of 1860 was by no means a humdrum Budget; it excited a good deal of interest. Unfortunately, the intelligence department of the telegraph companies failed to report the Budget for the *Western Morning News* with reasonable correctness. Amongst other glaring errors, they telegraphed that the income tax was raised to 1s. 2d. in the pound. Naturally, such a report created much alarm, and this alarm became ridicule when the errors were discovered. In response to his complaints, Mr. Saunders was informed by the intelligence department of the telegraph companies that if he did not like their reports, he need not take them, that he should not have them if he continued to grumble, and that he must come to London and see the chairman, if he wished the telegraphic supplies to be continued. This interview took place, and there was a good deal of plain speaking. It was claimed on behalf of the telegraph companies that although they carried on their general business under powers conferred by Parliament, they were under no control in supplying news, which was a matter beyond the contemplation of Parliament when their general powers were granted; therefore they had an absolute right to supply or withhold their news, and unless the proprietors of the *Western Morning News* apologised for their complaints, the supplies to that paper would be stopped. Mr. Saunders replied that if they possessed such powers, and intended to use them as proposed, it was useless to attempt to carry on a newspaper; it would be better at once to stop the *Western Morning News*, rather than wait until more money had been expended upon the undertaking; that if the telegraphic supplies were stopped, he would test the powers of the telegraph company by claiming damages, and if unsuccessful in this claim, he would make it his business to expose the atrocious claims of the telegraph companies, and obtain, if possible, a remedy which would make the press as free as it was supposed to be. The telegrams were not stopped."

Telegraph Material Wanted.—The Highland Railway Company wants tenders (by the 25th inst.) for the supply of telegraph instruments and fittings, and telegraph construction material. Forms may be obtained of Mr. J. G. Bulmer, storekeeper, Inverness. The India Office is advertising for tenders for the supply of component parts of iron telegraph posts for India. Conditions of contract may be obtained from the Director-General of Stores, India Office, Whitehall, S.W.; tenders to be sent by 2 p.m., on the 28th inst.

Telegraph Jubilee.—We are pleased to find that our suggestion contained in the last issue of the REVIEW in an article entitled "After Fifty Years," has quickly found a response. An influential committee has since been formed for the purpose of giving a dinner on a large scale on July 27th, and it is expected that a considerable gathering of members of the telegraphic profession and others interested in the progress of telegraphy, either scientifically or financially, will be brought together.

The Incandescent Gas Light Company.—At the statutory meeting of this company, Mr. Henry Wollaston Blake, the chairman, said that although no definite agents had been appointed and no advertisements issued, the spontaneous applications for the light had kept the *employés* of the company fully employed. A factory had been started on a small scale in the city, and premises for manufacturing the mantles on a large scale had been engaged in other parts. They had had to import persons from Vienna to instruct their *employés* here in the mode of manufacture, and these latter were rapidly becoming efficient, although the time for teaching had been very short. Notwithstanding that they had practically only existed six weeks, and had taken no special steps to obtain orders, they had already got no less than 500 customers. They had fitted the light in five theatres—the Olympic, the Gaiety, the Prince of Wales's, the Lyceum, and Drury Lane; in the Whitehall Club and Willis's Rooms, where 150 lights had been employed. They did not require gas of a very high illuminating power with their lights, as very ordinary and inexpensive gas would answer every purpose. Mr. James Mactear said the French company had made great friends with the French gas companies, the latter regarding the light as a means of combating the electric light. Both Mr. Mactear and the chairman spoke of the difficulty which had been experienced in getting a supply of burners from the manufacturers to whom the orders had been given; they made a contract with a Birmingham firm to provide them with burners (30,000 had been ordered from three different parties) in a certain time, and it was only another instance of the unsatisfactory condition of the manufacturing industry of England that those people were nearly six weeks beyond the time for delivery. The first supply had now come to hand, and it was hoped that they would soon be able to overtake most of the pressing orders and look for new business.

Electrical Club for Chicago.—The electricians of Chicago have decided to form an electrical club, procure rooms, and set about forming a library. May they be successful.

Physical Society (June 11th).—Mr. Shelford Bidwell, F.R.S., vice-president, in the chair. A number of Puluj and other vacuum tubes were exhibited by Dr. Warren de la Rue. The Puluj tubes consisted of a phosphorescent lamp, and radiometers with phosphorescent vanes and mica discs painted with phosphorescent substances. The other tubes contained different phosphorescent minerals, such as magnesium carbonate, calcium silicate, and Iceland spar. When illumined by a large induction coil beautiful colour effects were produced. "Note on Messrs. Vaschy and Torranne's Method of Comparing Mutual Induction with Capacity," by Prof. G. C. Foster. In November last, the author described a method of comparing the mutual induction of two coils with the capacity of a condenser. Since then he has found that a very similar method was used by Messrs. Vaschy and Torranne in July, 1886, and published in *The Electrician* the following month. The formulæ are identical, and the difference consists in interchanging the galvanometer and the variable resistance, *p*. Messrs. Vaschy and Torranne's arrangement has the advantage that the resistance of the secondary coil need not be known. Prof. Foster's method had been used by one of his students (Mr. Draper) about two years ago, but priority in publication belongs to Messrs. Vaschy and Torranne. A note on "Magnetic Resistance," by Profs. Ayrton and Perry was postponed.

The British Association.—In anticipation of the Manchester meeting, Prof. Silvanus Thompson is moving for reforms in regard to sectional procedure. He suggests earlier commencement for the daily meetings of the sections, and the continuation of those meetings to the final Wednesday. Another important department which he recommends, is the announcement on the opening day of the days and hours appointed for the reading of papers on particular topics. "As an instance," he says (in last week's *Nature*), "I will only mention that many of the members of the Committee on Electrolysis, of which Prof. Lodge is secretary, are looking forward to a full and interesting discussion of their report, in which discussion they especially anticipate that an important part will be taken by their distinguished Continental visitors. Knowing this to be the case, why cannot the Council fix beforehand a day and hour for this matter, which is to many of the physicists and chemists the most importont event of the meeting, more important than the addresses of Presidents of Sections, more important than the set evening discourses, more important even than the address of the President himself?"

New Fellows of the Royal Society.—The annual meeting of the Royal Society for the election of Fellows was held at the society's rooms in Burlington House on Thursday last week, when the following gentlemen were elected into the society:—John Young Buchanan, M.A., John Theodore Cash, M.D., Sir James Nicholas Douglass, M.I.C.E., Prof. James Alfred Ewing, B.Sc., Prof. George Forbes, M.A., William Richard Gowers, M.D., Prof. Alexander B. W. Kennedy, M.I.C.E., George King, M.B., Sir John Kirk, M.D., Prof. Oliver Joseph Lodge, D.Sc., Prof. John Milne, F.G.S., Rev. Octavius Pickard-Cambridge, M.A., George James Snelus, F.R.C.S., Thomas, Lord Walsingham; William Whitaker, B.A.

"Electrical Plant."—Under the title of *Electrical Plant* Messrs. Wheatley Kirk, Price & Goulty, have just issued the first number of a register, which they intend to publish monthly, of new and second-hand electrical plant, apparatus, fittings, &c., for sale and wanted. The object is stated to be to supply information respecting the numerous machines and appliances all over the country which, having been used for temporary purposes and being no longer needed, are for disposal. Judging from the first list there seems to be ample material for a periodical circular of this kind, and in serving the interests of electricians and their customers we trust the publishers will find the venture remunerative to themselves.

Questionable Wisdom.—Cases are conceivable where it is right that the individual should continue to suffer inconvenience in order that the majority may be spared an infliction. The following incident supplies the clue to our meaning. Miss Eulah Wilcox, of Paducah, Ky., while visiting with friends, complained of dizziness and asked for camphor. When this was brought it was found that she could not utter a sound. For one week she was perfectly dumb, but otherwise in perfectly good health. Then a powerful shock from a galvanic battery was given to her, and soon afterward her voice returned as suddenly as it left her.

Electric Traction in Brussels.—The Brussels correspondent of *Industries* briefly intimated last week that electric traction in that city had been interrupted for some days, an accident having taken place at the charging station.

Patents in America.—The United States Government has announced its intention of joining the International Union for the Protection of Industrial Property. The principal effect of this accession will be that in future, an inventor who applies for a patent in the United States will have priority over all subsequent applicants, not only in the United States, but in all countries belonging to the international union, provided that he applies for patents in the other countries of the union within seven months from the date of his application in the United States.

Personal.—Mr. W. Brooks Sayers, who was engaged for years with Messrs. Crompton & Co., and has more recently been manager to Messrs. Chamberlain and Hookham, has now commenced business for himself in Birmingham. We wish him all success.

Electricity at the City and Guilds Institute.—The course of lectures given by Prof. Ayrton in the spring on "The testing of dynamos and motors" at the Central Institution of the City and Guilds of London Institute, was so sucessful that it is to be repeated with additions during the first two weeks in July. The subjects to receive attention are, series dynamo, shunt dynamo, compound wound dynamo, self-induction and its measurement, alternate current dynamo, mechanical measurement of power, measuring joint efficiency of coupled dynamo and motor, motor. Mr. R. T. Glazebrook will give a course of lectures on evenings in July on "Methods of determining the fundamental standards of electrical measurements."

A Racing Story.—The solemn service was progressing in Winchester Cathedral, and the Dean sat enthroned, when a telegram was handed to him. He opened it, and cast his eyes up to heaven in dire perplexity. It ran thus: "Ormonde has won." Who was Ormonde? and what had he won? Vainly canons and such-like minor lights were consulted. If they knew they pretended not to. It was subsequently discovered that the telegram had been sent to Mr. Dean, a trainer at Winchester, but as it was addressed "Dean, Winchester," it was handed to the Dean. The telegraph clerks were probably under the impression that this dignitary had put a trifle on the race, and had desired that the result should be at once forwarded to him.

Electricity in China.—From a cutting forwarded us from the *Hong Kong Daily Press* we observe that electrical science is not neglected in China. The paper gives an account of the inspection by the Viceroy and the Governor of Canton of the fortifications and submarine defences of the river, and states that the large electric search light of 36,000 C.P., erected by Mr. J. A. Betts, C.E., three years ago, to guard his submarine mining fields, was brought into use, and threw a brilliant beam of light on the fleet, much to the gratification of the Viceroy. Mr. Betts and his students in the Torpedo Department and Torpedo School also carried out a number of electrical experiments for the edification of their eminent visitors.

An Irascible Electrician.—At the Hammersmith police-court, on Wednesday, Samuel Smith, a Civil Service clerk, was charged with shooting Paul Ward, an electrical engineer, residing in Hurlingham Lane, Fulham. The prosecutor, who had been injured in the left side of the neck, said on Tuesday evening he had an altercation with his wife, who tried to knock him down, but he put her down. There were words and physical violence. The prisoner, who was a lodger, knelt upon him.—Mr. Paget: You put your wife on the ground, and he put you on the ground?—Witness: Yes; he knelt upon me and bruised me. I was enraged, went upstairs, and put a revolver in my pocket, because he is a violent man.—Mr. Paget: Was the revolver loaded?—Witness: I believe it was. It is here. I went down and went out to seek him. I did not find him. I came back and found him inside his room with the door locked. I said he deserved to be shot, and demanded of him to open it. He replied with something insulting. I burst the door open and he fired a rifle at me.—Mr. Paget: What was the consequence of the discharge?—Witness: The ball passed along my neck and grazed it.—Mr. Paget: Did it make the marks upon your face?—Witness: No; I believe they were caused by the metal of the cartridge. I was blinded by the smoke, and I went to my room.—Mr. Kisch: Did you intend to shoot him?—Witness: No, certainly not. I wanted to obtain reparation for the insult. I believe the revolver was loaded in two chambers. I loaded it five years ago, not since.—Emily Ward, the wife, said her husband returned home the worse for drink. He threw her down and the prisoner pulled him off. Her husband went upstairs. She saw him come down and fall with the revolver in his hand. He went out, and she said to the prisoner, "Ward has got a revolver; pray shut yourself in your room—as he is threatening to shoot you." While her husband was outside the prisoner's door she heard him use bad language and threaten to shoot him. She then went down to look for assistance.—Dr. Middleton, who was called to the complainant, said he found a gunshot wound on the left cheek, extending to the neck, three inches in length. The marks on the face were caused by the discharge.—Inspector Rawlings said he examined the premises, and found a large hole in the wall opposite to the door. He found the bullet on the floor. He produced the rifle, which belonged to the Volunteers. The prisoner told him that he fired the rifle in self-defence.—Mr. Paget remanded the prisoner, and allowed bail.

The Hercules Turbine.—A new pamphlet of 84 pages has been issued by Mr. John Turnbull, Jun., of Glasgow, on "Water Power and the 'Hercules' Turbine." It contains general directions for the measuring of the quantity of water in streams and for ascertaining their power, as well as information on essential points involved in the proper erection of turbines. The weak point of turbines is explained, and the manner of overcoming it in the design and construction of the "Hercules," which is shown by comparison with others to possess as high an efficiency as any at "whole gate," while at "part gate" its percentage of efficiency is the highest of all. Illustrations are given of the turbine and of various modes of fixing, together with a number of tables, which render the little book a complete epitome of information on the subject treated.

An Electric Trumpet.—An electric trumpet has been recently devised by M. Zigang. It consists of a short brass tube mounted on wood and containing an electro-magnet whose ends face a vibrating plate, on which is fixed a small piece of soft iron. Against this plate armature rests a regulating screw with platinum point, which serves for automatic interruption, by vibration of the armature. With two Leclanché elements a musical sound is obtained, which may be varied in pitch, intensity, and timbre by means of the screw. This instrument may be usefully employed in signalling on ships, railways, tramways, &c.; it may also serve as a receiver for signals of the Morse type.

Physics at Oxford.—At a recent meeting of Convocation at Oxford, a proposal was brought forward by Prof. Price to grant £4,800 for building a lodge for the caretaker of the Physical Laboratory, for making additions for the teaching of electricity, and for temporary buildings to hold the dynamos offered as a present by Mr. H. Wilde, F.R.S. Prof. Price pointed out the importance of the subject in the future. The University was under great obligations for the instruction afforded by Christ Church, Balliol, and Trinity Colleges; but college instruction and plant must be insufficient. There had hitherto been higher instruction given to Fellows, Professors of other places, &c., but the instruction now to be provided was elementary. Dr. Markby proposed the adjournment of the discussion on the ground that the facts of the case had not been duly considered. Two colleges, Balliol and Trinity, thought they had provided part of what was asked for. This might be a mistake, but it should at all events be considered. The President of Trinity was in favour of the adjournment; but Prof. Clifton urged that the proposal had been in hand for some years, and that the subjects in question were entirely distinct from those provided for by Balliol and Trinity. The adjournment was rejected by 95 votes to 49. Prof. Rücker, speaking from a wide experience of laboratories, said that while in light and heat the Oxford laboratories were second to none, in electricity Oxford was distinctly behindhand. Students of the subject had to go to Cambridge or Germany. Prof. Clifton's plans were not at all extravagant. He should be enabled to carry forward this department as he had done others. The Bodleian Librarian wanted to know what other outlays would be required for natural science within, say, five years. It was impossible meanwhile to get the requisite funds for the Bodleian. Prof. Freeman, without going into the merits of the proposal, objected to an expenditure which involved drawing upon capital. Prof. Clifton denied that the establishments at Balliol or Trinity met the case. Mechanics was not physics. If the grant were refused, Oxford students would be placed at a great disadvantage. The proposal was thrown out by 89 votes to 52.

Another Argument for Electric Locomotion.—Last week in a brief hour, says the *Electrical World* for June 4th, the whole of the motive power of one of the largest street car lines in this city was wiped out of existence, 1,200 horses dying horribly in the flames of a sudden and unexplained fire. Now that this awful accident has happened, everybody is crying out: "The car stables must go." It sometimes needs a catastrophe of this character to arouse public attention to the need for reform, and there can be no doubt that the Belt Line fire has many lessons to teach, the principal among which is the one that street car stables, no matter how well conducted, are a nuisance in large cities, and should be abolished. The only excuse for them has been that horses were needed to run the cars, because steam was inadmissible. Now, however, the cable system and the electric motor have both demonstrated their great superiority over horseflesh, and electricity has exemplified in various ways its greater economy and flexibility than the cable. We have not the slightest hesitation in affirming, that if electricity is given a fair trial on the Belt Line, it will prove itself adequate to every emergency, and once and for all settle the question as to the right form of power to use for locomotion in large cities.

Electro-Deposition of Iridium.—Mr. William L. Dudley, of Covington, Ky., U.S.A., has patented a process for depositing iridium, by which, he states, a bright, reguline deposit of the metal is obtained. Solutions of the double chloride of iridium and sodium, or double chloride of iridium and ammonium are employed. The first-named solution is prepared as follows:—The hydrate of iridium is dissolved in the least possible quantity of hydrochloric acid, and evaporated to expel excess of acid, the residue is then dissolved in water, and an equivalent proportion of chloride of sodium added. The solution is then diluted until it contains two ounces of metallic iridium in each gallon of the liquid; it is finally acidified with sulphuric acid, in the proportion of half an ounce of acid to the gallon. The solution of double chloride of iridium and ammonium is prepared by dissolving the hydrate as before, and carefully neutralising the liquid with ammonium hydrate, sulphuric acid is then added until all the precipitate produced by the ammonium hydrate is dissolved. The solution is then diluted and acidified as in preparing the former bath. Mr. Dudley states that a plate of iridium or phosphide of iridium, as made by the Holland process, if used as an anode, dissolves in these solutions under the action of the current. It is recommended to employ a current of low intensity, otherwise the deposit becomes dark and powdery, while there will also be excessive evolution of gases from the electrodes. The baths may be worked in a neutral condition, but acid solutions are preferred. When a thick deposit is required it may be necessary to remove the articles from the bath and wipe them (query scratch-brush), from time to time if the deposit has a tendency to become black. By keeping the articles in motion, while in the bath, it is said that the deposit takes faster (?), and will be brighter and thicker than if allowed to remain stationary.

The Eclipse Voltaic Battery.—Last Saturday afternoon, at the White House, Telegraph Street, Mr. J. J. Walsh gave an exhibition of the Eclipse Battery, the invention of Mr. Harris. The battery consists of eight cells in two sets of four, each set being enclosed in a small cabinet. Wires, a few inches long, conduct the two currents to an incandescent lamp, which can be constructed in any shape or design. The invention is said to be peculiarly adapted to the lighting of railway carriages, omnibuses, and cabs, and importance is also attached to its suitability for use as a miners' safety lamp. The inventor claims for the "Eclipse" that it makes the lighting of dwelling-houses by electricity a very easy matter, both on the score of simplicity and cheapness. We have heard the same thing before. There seems just at this moment to be quite a revival in the up-springing of "eclipse" primary batteries. Perhaps the proprietors of Mr. Harris's invention will give us an opportunity of testing its capabilities.

The Address of Venus and Adonis.—The non-delivery of a telegram sent from Manchester to Lichfield a week or so ago was attended by some amusing circumstances. Some old tapestry was lent by Mr. Litchfield, an art dealer, to the Jubilee Exhibition, and, requiring the return of a certain panel, he particularised it in his telegram by stating the size and subject, "Venus and Adonis," ending the message with sender's name "Litchfield." A clerk at once replied to "Venus and Adonis, Lichfield," and after making every effort to deliver the message, the Post Office officials were constrained to wire back to Manchester that no Venus and Adonis could be found in the cathedral city.

Electric Road at Asbury Park, N.J.—A tramway line, to be worked by electric motors, is to be laid at Asbury Park, New Jersey. Fifteen cars are to be put on the road, and all will be lighted by electricity. There has been a little competition amongst the motor companies for the working of this line, the Daft Company bidding $2,300 per annum for a 10-year term, and $3,000 yearly for 20 years, whilst the Van Depoele Company offered 5 per cent. on the gross earnings annually, provided they exceeded 6 per cent. on the investment, 1 per cent. to be deducted for each 1 per cent. short in the income, if 6 per cent. were not reached.

Our Columns.—We have still a heavy pressure upon our space, and owing to this issue containing the index we are compelled to leave over several articles of importance until a more suitable opportunity occurs for producing them. It may be interesting to our readers to note that we have now reached our 500th number.

A Scandinavian Exhibition.—An exhibition of industry, agriculture, and art is announced to be held at Copenhagen in the year 1888. The committee invites British manufacturers to participate in the exhibition by sending a collection of art-industrial products of superior quality. The exhibition will be opened on the 18th May, 1888, and closed on the 30th of September of the same year; but, if convenient, the committee may keep the exhibition open during the month of October. Art-industrial produce in precious metals, bronze, wood, clay, &c., of British manufacture will be exhibited, if found suitable for exhibition by a committee appointed by Great Britain. A space, not exceeding 800 square metres of floor area, will be allotted to Great Britain in the principal building of the exhibition, adjoining the other chief countries. A copy of the prospectus issued by the executive committee may be seen on application at the Commercial Department, Board of Trade, S.W.

New Volume.—As much disappointment was experienced by new subscribers who in January and February were unable to obtain the back numbers from the commencement of the volume, we would remind all concerned that the next number (No. 501), July 1st, commences a new volume.

American Telephone Patents.—Prof. Elisha Gray has applied for permission to amend his original application for patent in the celebrated telephone interference case of Bell, Gray, Edison, McDonough, *et al.*, upon which a decision adverse to him was rendered in 1879. Mr. Casey Young, who appeared for Gray when argument was heard a week or so ago in the Patent Office on behalf of Prof. A. G. Bell, declined to make any argument in support of his application, on the ground that the law and the rules of the Patent Office provide that all pending applications for patents and all amendments must be kept in the secret archives of the Patent Office until an interference is either declared or refused. It was insisted that no notice should have been given to Bell or to any one else of the pending application in this case, as was done by Examiner Brown. Mr. Conkling, on the other hand, representing Bell, declared that the efforts of Gray's counsel to prevent a full hearing in the case were "scandalous in the extreme, and without a precedent in the history of the Patent Office." One of Gray's original claims was for "a telephonic receiver, consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality." The change or amendment now proposed is to insert the word "metallic" before the word "diaphragm" in the above. It is stated that if the application is granted the amendment will so broaden the scope of Gray's invention as to result in a new interference, and hence in a reopening of the whole case, in which, in 1879, Bell was declared to be the prior inventor. Decision was reserved.

An Electric Watch Light.—The *Daily Telegraph* describes what it terms "A novel and serviceable adaptation of electricity," due to the ingenuity of Mr. T. White, philosophical instrument maker. With the current supplied by a small Leclanché battery a minute incandescent lamp is lighted, which can be applied to a vast variety of useful purposes on the many occasions when light is wanted instantaneously or for comparatively short periods. In the sick room to note the time or call assistance, in the sea-captain's cabin to consult a chart, or the officer's tent to write or read a despatch. This handy apparatus, our contemporary thinks, might illustrate one more of the countless possibilities of electricity to serve the purpose of everyday life.

Electro-Deposition of Iron.—In a paper read by Prof. W. Chandler Roberts-Austen, F.R.S., before the Iron and Steel Institute, the author described the methods he adopted to form a deposit of iron by means of an electric current, and gave some interesting data regarding the quality of the iron so obtained. The electro deposition of iron is not a new art, and it has, in fact, already been practised in Russia for the manufacture of iron types, from which the Russian bank notes are printed; one of these plates was shown to the meeting. But as regards this country, Professor Austen is probably the first who has succeeded in an operation which presents some unusual difficulties. The secret of his success seems to be the very feeble current which he employs. He uses a wrought iron anode placed opposite a cathode at a distance of about 1½ inches, and for a surface of about 90 square inches the current employed is only ·089 of an ampère, given by two Smee cells coupled in series. The solution is a mixture of ferrous sulphate and magnesia sulphate. With so feeble a current the deposition naturally proceeds at a very slow rate. The matrix for the Jubilee medallion, which was shown, took three weeks to produce. The procedure is as follows:—The cathode is of copper on which a thin coating of nickel has been electrolytically deposited. This is left in the air to slightly oxidise; then it receives a second deposit of nickel, and upon that the iron is thrown down. The chemical and magnetic properties of the iron so deposited are very remarkable; it is almost chemically pure, containing only a very slight trace of magnesium and ·005 per cent. of sulphur. Its density when taken out of the bath is 7·675, but after annealing the density rises to 7·811, whilst at the same time a contraction in length of about 1 per cent. takes place. The magnetic susceptibility of the unannealed iron is surprisingly low, and that of the annealed sample is only about two-thirds of the value generally found for Russian soft wrought iron. The low density and low magnetic susceptibility are probably attributable to the large amount of occluded hydrogen which during the process of annealing is driven off, with a corresponding improvement in the quality of the metal. Prof. Austen also showed a plate of iron on which copper had been deposited. To the back of the iron plate was then glued a piece of wood and the deposit of copper was stripped off, but the split occurred not between the junction of iron and copper, as might be expected, but within the copper itself, leaving a portion of that metal firmly adhering to the iron plate. This shows that the cohesion between molecules of iron and copper, when the latter has been deposited electrolytically on the former, is greater than that between the copper molecules amongst themselves.

NEW COMPANIES REGISTERED.

Aluminium Company, Limited.—Capital: £400,000 in £5 shares. Objects: To acquire the inventions and patent rights of Mr. James Webster for the manufacture of alumina, aluminium and certain metallic alloys, together with the business of Webster's Patent Aluminium Crown Metal Company, Limited. A full description of the invention is not given, we are therefore unable to state whether or not the process is electrical. Signatories (with one share each):—*G. W. Balfour, M.P., 32, Addison Road; * Sir Andrew Clarke, R.E., 52, Portland Place; * W. Anderson, C.E., 3, Whitehall Place; * W. Mactaggart, 24, Leadenhall Street; * H. J. Castner, 5, Belvedere Road, Lambeth; P. F. Tidman, C.M.C., Chislehurst; F. S. Courtney, C.E., Palace Chambers, Westminster. Directing qualification: 200 shares or £1,000 stock. Remuneration: £2,500 per annum. Sir H. E. Roscoe and the subscribers denoted by an asterisk are the first directors. Registered 18th inst. by Baker, Blaker & Hawes, 117, Cannon Street, E.C.

Anglo-Portuguese Gas and Water Company, Limited.—Capital: £1,000 in £5 shares. Objects: To acquire a concession from the Municipality of Tiguerra-da Foz, Portugal, for supplying that town with gas and water, and generally to carry on in Portugal the business of supplying gas, water and electric light, and electric and hydraulic

force. Signatories : * R. Murdoch, Glasgow ; * R. Laidlaw, Glasgow ; * A. F. Phillips, C.E., St. Albans ; * T. C. Horsey, C.E., Preston Park, Brighton ; * H. P. Mundey, 73, Linden Gardens, Bayswater, 200 shares each ; T. N. Kirkham, C.E., 7, Palace Chambers, Westminster, 20 shares ; J. M. Smith, 6, Crosby Square, 1 share. Directors' qualification : 200 shares. Remuneration : £150 per annum with £50 additional for each 1 per cent. dividend on the ordinary shares above £10 per cent. per annum. Registered 17th inst. by R. Byron Johnson, 49 and 50, Parliament Street. The signatories denoted by an asterisk are directors.

Magnetic Bell and Signal Company, Limited.—Capital : £100,000 in £1 shares. Objects : To acquire patent rights for electrical inventions and for appliances to be used therewith. Signatories (with 1 share each) : J. R. Blundstone, Victoria Mansions, Westminster ; J. Harker McKean, 113, Angell Road, S.W. ; C. J. Daniell, Kings Langley, Herts ; J. Allison, 139, Hungerford Road, N. ; C. Spicer, 20, Old Broad Street ; H. J. Smith, 16, Dorset Road, South Lambeth ; F. W. Bridges, 120, Cloudesley Road, N. Three of the first directors are to be appointed by the Compagnie de Signaux Magnetiques et Communication Telephonique de Paris. Qualification for ordinary directors : 100 shares. Remuneration : £300 per annum to the chairman and £150 per annum to each other. Registered 16th inst. by Snell, Son & Co., 1 and 2, George Street, Mansion House. Office : 2, Austin Friars.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-Portuguese Telephone Company, Limited.—An agreement of 8th inst. provides for the purchase by this company of the telephone business carried on by the Edison-Gower-Bell Telephone Company of Europe, Limited, in Portugal, including the exchanges and private lines in the cities of Oporto and Lisbon. The purchase consideration is £50,000 in fully-paid shares.

Self-Winding Clock Syndicate (Foreign Patents), Limited.—The statutory return of this company, made up to the 23rd ult., was filed on the 14th inst. The nominal capital is £15,000 in £10 shares ; 857 shares have been allotted, and the full amount has been paid thereon.

At an extraordinary general meeting held at the offices, 12, Queen Street, E.C., on the 23rd ult., the following special resolution was passed : "That the regulations contained in the printed document submitted to the meeting, and for the purpose of identification subscribed by the chairman thereof, be and the same are hereby approved, and that such regulations be, and they are hereby adopted as the regulations of the company to the exclusion of all the existing regulations thereof." The special resolution was confirmed on the 8th inst., and duly filed on the 18th inst.

CITY NOTES.

The South of England Telephone Company, Limited.

THE report of the directors for the twelve months ending 30th April, 1887, states that during the year the sum of £16,077 9s. 5d. has been expended on account of capital, making a total of £27,926 19s. 11d.

The revenue account shows a gross income of £7,584 15s. 8d., and a net credit balance of £1,059 11s. 5d., making, with the sum of £727 3s. 7d. brought forward from last year, an available balance of £1,786 15s. 0d., from which has to be deducted £728 6s. 0d. for preference dividend, leaving a balance of £1,058 9s. 0d., which it is proposed to carry forward.

The heavy snowstorm of the 26th December last, which was immediately followed by very strong winds, had a most disastrous effect upon the company's wires, the damage, however, was fortunately confined to the northern districts; the entire expenses attending the reconstruction of the lines have been charged to revenue account. In carrying out the new work care has been taken to obviate, so far as possible, a recurrence of a similar disaster.

During the past year trunk lines have been run as follows :—Norwich — Great Yarmouth ; Northampton — Wellingborough ; Chatham—Maidstone ; Dover—Folkestone.

A trunk line between Margate and Ramsgate is in process of construction, and arrangements are also being made for connecting Brighton and Worthing, and Brighton, Lewes, and Eastbourne.

The growth of the exchange and private line business may be considered favourable, as shown by the following statement :—

	Exchange Subscribers.	Private Line Renters.
April 30th, 1886 ...	687	248
April 30th, 1887 ...	1,130	348
Increase ...	443	100

Telephone exchanges are now open at the following places :—Brighton, Cambridge, Chatham, Dover, Eastbourne, Folkestone, Great Yarmouth, Hastings and St. Leonards, Ipswich, King's Lynn, Luton, Maidstone, Margate, Northampton, Norwich, Oxford, Peterboro', Ramsgate, Reading.

Eastern and South African Telegraph Company, Limited.—The coupons due on July 1st on the 5 per cent. mortgage debentures will be paid by Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C. Coupons should be left three clear days for examination.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 17th were £3,841, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th inst. are £2,785, as compared with £2,452 in the corresponding period of 1886.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending June 17th amounted to £4,663.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

5078. "Improvements in electric lighting apparatus for use in wheeled vehicles." R. WEBER. Dated April 12. 8d. Claims: 1. The arrangement of a dynamo so as to be operated by friction against the tire of a wheel of the vehicle, in combination with an electric lamp electrically connected to the same. 2. The dynamo with wheel in combination with the incandescent electric lamp and lever, catch ring, and spring, for engaging and disengaging said dynamo, substantially as illustrated and described.

5089. "Improvements in electric arc lamps." F. FESQUET and S. J. COMTE OSTROROG. Dated April 12. 8d. Claims :—1. The arrangement of two compensating solenoids actuating, through their cores, on which they act in opposite directions one arm of an oscillating beam, in one or the other direction according to the amount of current prevailing in one or the other solenoid, substantially as described and illustrated. 2. The arrangement of a feeding mechanism suspended at the other end of the aforesaid oscillating beam, and consisting of a rack with its carbon holder, a pinion, a wheel with a ratchet wheel and pawl, a brake which is released through the action of a lever coming into contact with a fixed stop; the said feeding mechanism being, when the lamp is at rest, heavier than the cores, but when the lamp is burning in normal conditions, nicely balanced with the cores and the attraction exerted upon them by their solenoids, substantially as described and illustrated. 3. The arrangement for regulating the length of the arc by means of a single stop screw, substantially as described and illustrated.

5824. "Improvements in telephone transmitters." J. L. CORBETT. Dated April 29. 8d. Consists in suspending or balancing a contact piece connected to one terminal of the line upon a pivot pin or light spindle, so that at the point of contact it may bear upon the block or piece connected to the other terminal of the line with the pressure due merely to the tendency of the pivoted piece to attain the position of stable equilibrium. The suspended piece may be either the carbon button or the metallic contact point of the transmitter, or a carbon rod having in it a platinum or other pin may form one part, and a stationary or movable carbon block may form the other part of the contact points, the metallic pin or point being adjustable in each case. The suspended or balanced part may be hung from a pivot pin or be carried by an arm having a counter-balancing weight, the use of springs being dispensed with. The claims are 3 in number.

5825. "Improvements in telephonic apparatus." J. L. CORBETT. Dated April 29. 8d. Relates to a relay apparatus which automatically throws into circuit an auxiliary battery or batteries provided to supplement or reinforce the currents. The claims are 4 in number.

6220. "Improvements in electrical resistance switches." M. HOLROYD SMITH. Dated May 7. 1s. 1d. Claims:—1st. The improvements in electrical switches, which consist in so arranging the parts that by one continuous movement of the switch handle the resistances may be put into or taken out of the circuit by being connected first in series and then in parallel, or *vice versâ*, substantially as set forth. 2nd. The improvements in electrical resistance switches, substantially as described and as illustrated in the drawings.

6422. "Improvements in armatures for magneto or dynamo-electric generators or motors." J. G. STATTER and S. L. BRUNTON. Dated May 12. 8d. Claims:—1. The improved core for armatures for dynamo and magneto-electric machines formed of thin soft-iron discs called core rings, together with supporting rings, such as are described, the whole being held together by bolts with or without sheathings of insulating material, substantially as described and shown in the various figures of the drawing. 2. The improved core for armatures for dynamo and magneto-electric machines, formed of thin soft iron rings called core-rings, together with supporting rings, such as are described, held together by bolts passing through the supporting rings, but being only partially encircled by the core-rings, and without sheathings of insulating material, as described. 3. The arrangements for attaching improved cores to the axles, described and illustrated in the drawing. 4. The improved armatures for magneto or dynamo-electric generators or motors, described and illustrated in the drawing.

6471. "Improvements in electric telephony." J. G. LORRAIN. Dated May 13. 8d. The inventor employs a receiving instrument consisting of a close case fitted with a diaphragm. In this case there is a compound conductor, consisting of two wires or pieces of dissimilar conducting substances soldered together, or otherwise in intimate contact with one another. The two constituents of the compound conductor may be of any convenient size or shape, and they may be in contact with each other by simple pressure, or by rolling or twisting together, or by soldering, binding, or the like. In order to actuate this receiving apparatus, a transmitter, generating alternating currents, that is, one which—instead of varying the amount of electrical energy transmitted to the receiver, which is the action of the microphone transmitters now in use—causes currents alternating in direction to be transmitted, is employed. The claims are 3 in number.

6487. "Improvements in simple and compound switches for electrical currents." W. HARTNELL. Dated May 14. 1s. 1d. In the improved switches one of the surfaces is formed by the ends of a metallic brush or bundle of thin plates, by preference soldered together at the further end, projecting sufficiently beyond its support to leave it elastic. This brush is placed obliquely, say, at an angle of 45°, to the other surface of contact, which latter is rigid (or at any rate need not be elastic), and on being moved past t brush it springs each plate sufficiently to cause them to severa press against the rigid surface, a good contact is thus made o almost the entire area, and this notwithstanding any irregulari of surface or position, or the presence of any ordinary grit or d The claims are 9 in number.

6507. "Improvements in appliances for use in electric lighting." R. P. SELLON. Dated May 14. The inventor provides one or more magnets or solenoids which, upon the passage of a predetermined amount of current, attract an armature or core, which armature or core may interpose into the circuit or cause to be interposed into the circuit a sufficient amount of resistance or a sufficient number of additional devices, such as incandescence lamps, as to prevent injury to those previously remaining in circuit, and restoring them, if desired, to their normal condition of working. Claims:—1. The automatic safety device, substantially as described and illustrated. 2. The combination of a magnet or magnets wound with two circuits with an armature or armatures, and devices to prevent the oxidation of surfaces by sparking, all substantially as and for the purposes hereinbefore described.

6508. "Improvements in electric meters." R. P. SELLON. Dated May 14. 8d. Claims:—1. In an electric meter, indicating the passing current of electricity, by the employment of an oscillating or reciprocating link or rod, the extent of whose movement is varied by the extent of the current of electricity which it is desired to register, substantially as described. 2. In an electric meter, the method of varying the motion of an oscillating or reciprocating link or rod, consisting of a reciprocating pendulum upon which a link or rod is free to move, substantially as described and illustrated. 3. In an electric meter, the combination of parts, consisting of a reciprocating pendulum, a link or rod actuated thereby, and of which the motion is varied by an electro-magnet, with a registering device substantially as described and illustrated. 4. In an electric meter, means for varying the rotation of a fan, pinion, or an equivalent device, the speed of rotation of which is indicated upon a registering device, substantially as desbribed. 5. In an electric meter, the combination of parts, consisting of a fan, pinion, or equivalent device, immersed within a vessel containing a vapour gas or liquid, to which motion is imparted and controlled by an electromagnet, all substantially as described. 6. In an electric meter, the registration upon a drum or roll of paper of the value of the current of electricity passing, by means substantially as described.

6869. "Improvements in the transformation of heat into electricity and in apparatus for that purpose." C. CLAMOND. Dated May 21. 11d. Claims:—1. The construction of apparatus for transforming heat into electricity wherein metal pieces serving both to conduct heat and electricity and herein termed inter-contacts, are interposed between thermo-electric elements, the alternate inter-contacts being maintained at different temperatures, whereby electromotive force is generated independently of the temperatures of the different parts of the thermo-electric bodies, substantially as described. 2. Apparatus for transforming heat into electricity wherein the transmission of heat is controlled solely by the thermic resistance of the surfaces of thermo-electric bodies and of conducting bodies in contact, whereby active bodies of small thickness and limited mass are capable of being employed, as the thermic resistance of these bodies themselves is not required to effect the control of the transmission of heat, substantially as described. 3. The described arrangements of apparatus wherein the most favourable conditions for the transmission of heat into electricity are obtained by restricting the contact between the ends of inter-contact rods and the thermo-electric bodies, such contact being distributed over a number of different points on the opposite surfaces of the said bodies. 4. In the arrangement of thermo-electric apparatus referred to in the preceding claim, the grooving of the surfaces of the thermo-electric bodies between the points of contact with the inter-contacts so that on fracture occurring this will not affect the action of the contacts, substantially as described. 5. The construction of multiple thermo-electric currents, consisting of two or more blocks or plates of the same thermo-electric substance, or of different substances having the same electric action, connected together by metallic rods or pieces, substantially as described, whereby the useful effect of the element is increased. 6. The described manufacture of negative elements of sulphide of lead, in combination with metallic antimony for forming the contacts. 7. The construction of thermo-electric apparatus described, so arranged as to take up heat from the combustion gases of a fireplace and to transmit the same uniformly to the several elements composing the apparatus.

7463. "A new or improved electro-chemical etching process." H. E. P. DORN. Dated June 3. 4d. Claim:—The process for etching metal consisting in employing the metal plate to be etched and a negative plate of metal or carbon as electrodes of a galvanic current in an acid bath.

10186. "Improvements in electric generators and motors." C. W. HILL. Dated August 10. 8d. The armature is constructed by placing rings of brass or other non-magnetic metal at suitable distances apart upon a shaft; the rings have teeth on their periphery; between these teeth and parallel to the shaft are laid insulated rods of copper or other conducting metal. Upon the circular drum thus formed are threaded discs composed of ribbons of sheet iron and paper in separate layers; in the spaces between each pair of discs is an air space in each of which spaces is placed a spiral blade of ebonite or other suitable material which causes a current of air and keeps the armature cool when it is in motion. Over the ribbon discs are placed copper rods corresponding in number to the inner ones and connected to them in such a manner by radial strips of metal at the ends of the armature that a continuous spiral conductor is formed. At one end of the armature at suitable intervals in the conductor, holes are drilled, and on each bar of the commutator of the machine a projecting pin is secured which slides into one of the holes and so makes the connection. The brushes which collect the electricity from the surface of the commutator are preferably made of solid metal and they bear upon the commutator radially, in place of tangentially as customary; the brushes are mounted on sliding carriages arranged with springs so that each brush is fed forward as it wears away. The brush carriers are mounted on two levers arranged so that they can move independently or in conjunction with one another; the levers are also connected by worm gearing to an auxiliary electric motor so that as the load on the (dynamo) machine or motor varies, the auxiliary motor traverses the brushes automatically to the neutral position on the commutator. The claims are 10 in number.

CORRESPONDENCE.

Ironclad Transformers.

In the interesting series of articles by Mr. Rankin Kennedy on transformers, which appeared in your paper recently, the writer states on p. 299 (April 1st, 1887), that "in the 1885 patent of Zipernowski and Déri we have the *most novel* development of the ring, producing the highest class of transformer." The italics are mine.

In the following reference it appears, however, that the idea of encasing the wires in an iron sheathing for the purpose of increasing the induction is much older than all the other forms which he describes, and from which it is said to be evolved, except that of Faraday, which is only 13 years older.

In the British patent to Staite, No. 12,212, of 1848, on page 19, line 7, and in figs. 30 and 31, there is clearly described and shown a coil of wire or ribbon encased completely in an iron sheathing for the purpose of increasing the induction. It is clearly stated that the casing should be of iron, and that it should completely surround the wires of the coil, taken as a whole, precisely as in the Zipernowski-Déri system, with the further improvement of greater ease of access to the coil, but without protection against Foucault currents. It is termed an "intensity coil" for "improving the intensity of the electric current." He uses it as a self-induction coil, but the principle of increasing the induction by encasing the coil in iron remains, of course, the same.

I do not wish to detract from the credit which may be due to Messrs. Zipernowski and Déri, but offer this merely as a matter of general interest.

Carl Hering.

Philadelphia, *June 6th*, 1887.

Telephone Patents.

I have much pleasure in answering "Puzzled's" questions; and I hope you will please give me a little space, for I am afraid I cannot be as brief as you would wish. Perhaps the subject wants thrashing up again.

1. The "English Mechanic" telephone (in the general sense) consists of the usual electro-magnet in a case; the diaphragm being a membrane of any kind, with a small armature attached to its centre. The true "English Mechanic" telephone, however, should have a diaphragm composed of goldbeater's skin. The "English Mechanic" telephone is free to anyone. For, on the 9th December, 1876, Bell filed his patent in England. Previously, in August of the same year, the "English Mechanic" telephone had been described in this country in the pages of that enterprising journal, *The English Mechanic and World of Science.* Hence the name for this class of instrument. So, consequently, the great 1876 patent had to file its renowned disclaimer, which it did in 1878; and there is surely no doubt, that anyone who sticks an armature on to a diaphragm of any substance, which without that armature is not capable of inductive action upon a currrent of electricity, is clear of any claim of Bell's. If the armature, however, should itself vibrate tympanically, or be supported by anything but the diaphragm, then I should certainly say that that constituted an infringement of Bell's claim.

But who was the inventor of the "English Mechanic" telephone? "Puzzled" will perhaps ask. Why, Bell himself; and, therefore, on this score we owe a debt of gratitude to him, for he could easily have protected the "English Mechanic" telephone before publishing same at the Massachusetts Institute of Technology. He may, perhaps though, have thought that his English patent would include that form of telephone as well.

2. I do not quite know where the patent for Gillett's telephone lies. The diaphragm is of parchment. The "Stanhope" patents is in their diaphragm, which is of celluloid principally. When "Puzzled" asks for information about Prof. S. Thompson's instruments, he is doubtless unaware as to the nature of his request, for quite a large volume could be written as to the worthy doctor's doings in this line. His instruments in the market just now are the well-known Valve telephones; the receiver having a membrane diaphragm and a special electro-magnet arrangement for ensuring a strong magnetic pull at short ranges of distance. "Puzzled" may take it for granted, that the improvements in nearly all "English Mechanic" types of telephones lie in their diaphragms. It is one thing to know you may use membranes for diaphragms, but it is quite another thing to make those diaphragms, *i.e.*, commercially useful. Membranes make the best receivers, but, like many other little secrets in "telephony," you must understand how to work them up properly, and when you do know, "Keep it quiet." Diaphragms of parchment are exceedingly good speakers, but the substance is treacherous--it is so apt to stretch, &c. It is on this account that I am myself just bringing out an "English Mechanic" telephone, pure and simple, but with a new feature of "diaphragm regulation."

3. To be sure you are allowed to use an "English Mechanic" type of receiver with a microphone transmitter, provided the latter *does not possess* a diaphragm.

4. I presume "Puzzled" refers to diaphragms of microphone transmitters. Well, let him scrutinise the well-known "Blake transmitter"—*En passant*, does it ever strike the observer that this article is the legitimate offspring of Prof. Hughes's discovery? and that through his generosity "Edison" has "collared all the swag?"—he will there see a diaphragm in the undistorted sense of the term; and as many common-sense scientists are bold enough to imagine in the only sense that Edison ever meant. But what does "My Lord" say, on the strength of having received a *brilliant* and *rapid* electro-technical education at the hands of Mr. Bunkum, Q.C., and Mr. Tangle, Q.C., M.P.? "Certainly, if you place your microphones in a box, and speak directly on to them, you are an infringer." Now that the recent telephone scare is over (see the knock-down blow to Bassano & Co.), people are plucking up courage again and beginning to sell microphone transmitters; hugging themselves with the idea that they are not using diaphragms (legal) because the microphones are suspended in the air. Undoubtedly they are not, but, nevertheless, I am sorry for them, but more so, for their customers. Wait a little while till Messrs. Bunkum and Tangle (instructed by the "Disunited Monopoly Company") are to the fore again; and "My Lords" once more rehearse their scientific cramming process. I hope they won't succeed, but I am afraid that Messrs. B. and T. will convince "My Lords" that the very rooms where the instruments are in use are diaphragms; yes, that they can, if necessary, prove that the human body and the air are diaphragms within the meaning of "Edison's specification."

"Puzzled" will now see what a legal diaphragm is; and my humble advice to him, is, to stick for the present to telephones of the "English Mechanic" type (not imaginary "English Mechanic" type); then, I'll wager him a new hat he will never be bitten, which in these cases, alas, means ruination.

J. G. Ross.

June 18th, 1887.

Self-Regulating Motors.

Allow me through the medium of your paper to call attention to a sentence in Prof. S. P. Thompson's "Dynamo Electric Machinery" (second edition), which seems to me to be incorrect. It is on page 449, the subject being the regulation of shunt motors, and runs as follows: "A demagnetising series coil of appropriate power wound on the field magnet will, however, effect what is wanted, for then with any increase of speed, the resulting reduction in the field magnetism will at once bring down the driving power." Now, an increase of speed would result in a reduction of demagnetisation or increase of magnetism, and a reduction of field magnetism would increase the speed. Should not the sentence read thus? "A demagnetising series coil of appropriate power wound on the field magnet will, however, effect what is wanted, for then with any increase of speed the resulting increase in the field magnetism will at once bring down the speed." Increase of field magnetism would decrease the speed, because it would increase the counter E.M.F. of the machine.

C. G. McEwen.

Durban, Natal, *May 24th*, 1887.

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